MACHINE DESIGN

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● In doing this job for machinery manufacturers and users, the *ball* bearing is outstanding.

Because friction is practically eliminated in the ball bearing, there is no adjustment due to wear. This in turn means extreme Accuracy—not only in new machines, but throughout their *longer* life.

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Expect Exceptional Performance of
NEW DEPARTURE!

Throughout ten gruelling years, of two and three shifts every day, much of it at high speeds with carboloy tools...these New Departure ball bearings proved their ability to maintain accuracy under severe conditions.

NEW DEPARTURE

THE FORGED **STEEL BEARING**

2794

Itemized Index

CLASSIFIED FOR CONVENIENCE WHEN STUDYING SPECIFIC DESIGN PROBLEMS

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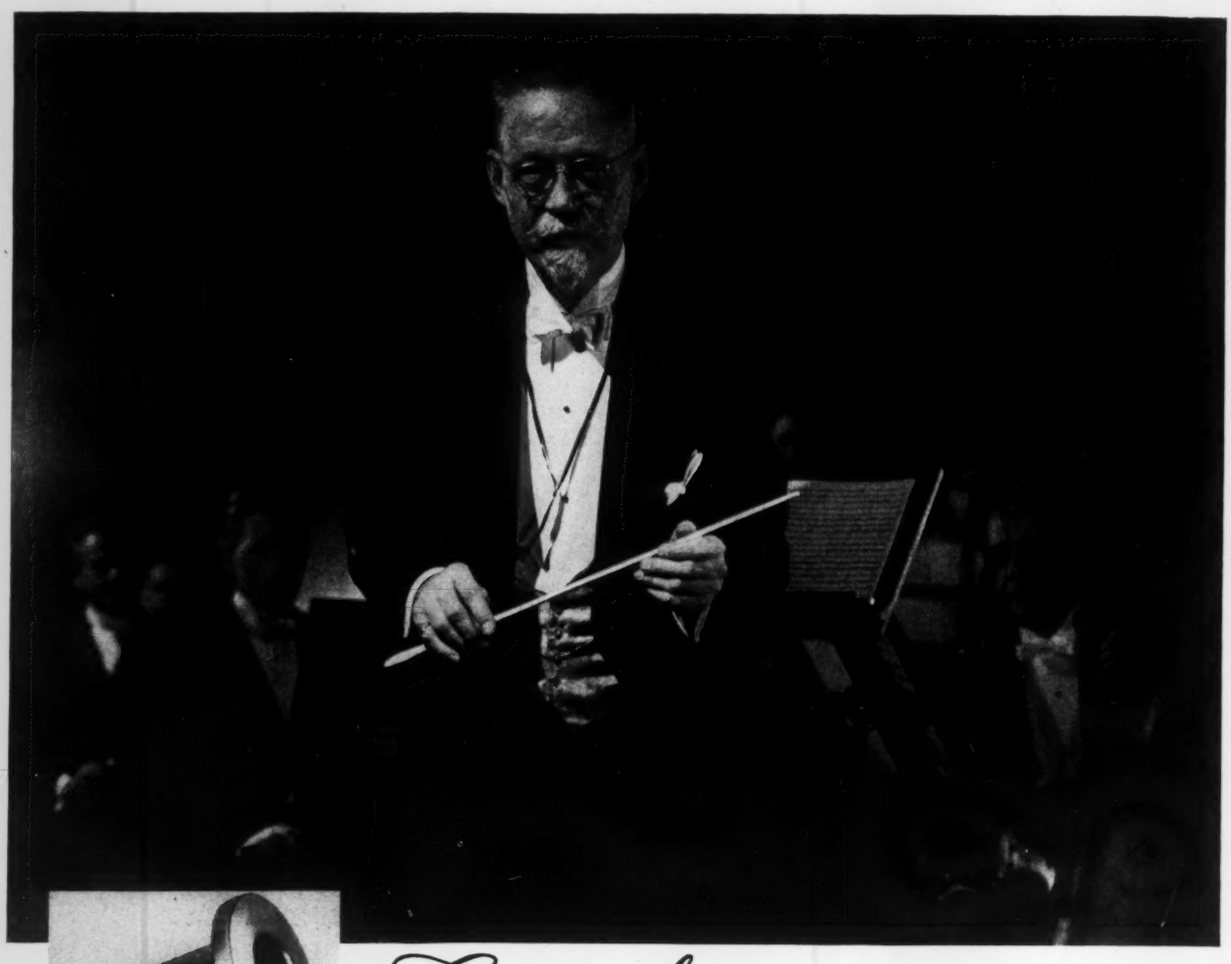

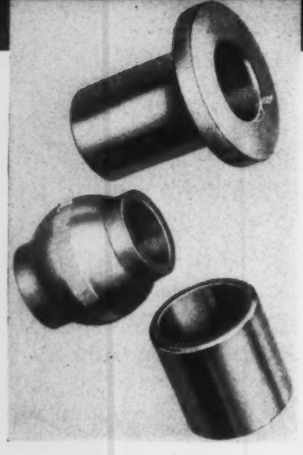

Tools on Hand
for thousands of Sizes
of Plain, Flanged
Self-Aligning and Special
Oil-Retaining Bearings

Leadership in Coordination

There can be no encore without patience, practice, application and coordination—the preparation and training for leadership—whether it's fiddles and oboes or wheels and gears.

After long years of leadership, we take a bow for COMPO Oil-Retaining Bearings; for we have acquired the skill and training so necessary for coordinating the properties of strength, structure and porosity in every COMPO Bearing application—achievements as varied as the machines in which the Bearings are used. Every COMPO Bearing is a finished study in coordination . . . and application.

WITHOUT OBLIGATION, WRITE FOR ILLUSTRATED BULLETIN

BOUND BROOK OIL-LESS BEARING CO.
(Established 1883) MAIN OFFICE and PLANT: BOUND BROOK, NEW JERSEY
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COMPO

OIL-RETAINING POROUS BRONZE BEARINGS

THE *Swing* IS TO VICTOPRENE OIL SEALS

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Exclusive Victor feature. Sealing element bonded to the shell. Patents Pending. Neoprene is the base of the Victoprene Sealing Element.

VICTOR MANUFACTURING & GASKET CO.
P. O. Box 1333 5750 Roosevelt Road Chicago, U. S. A.

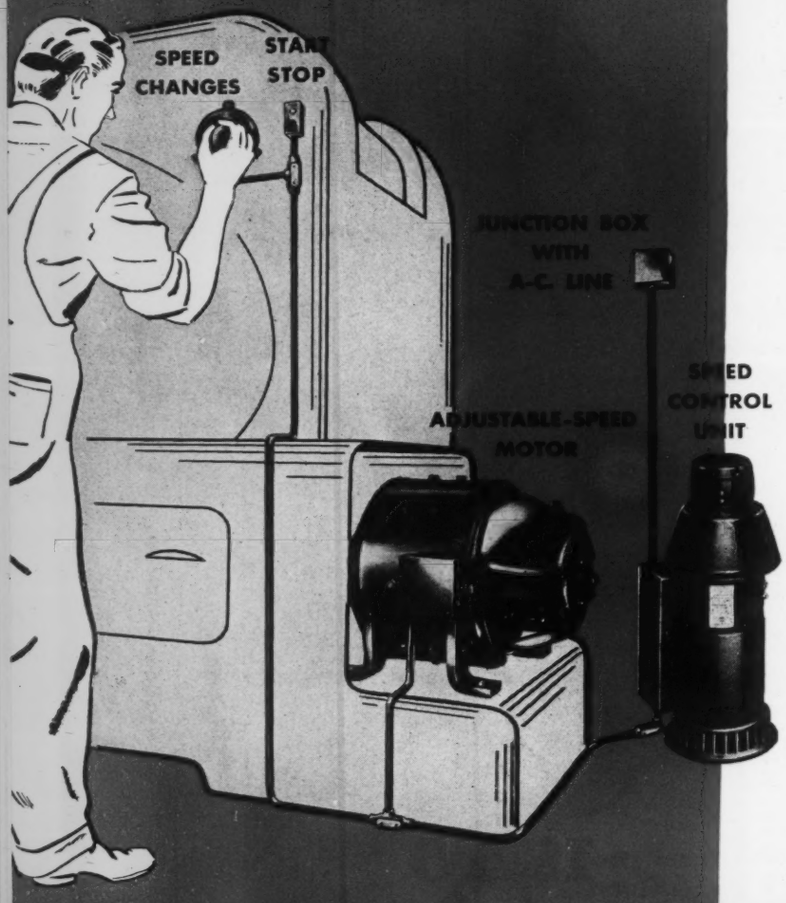
VICTOR

VICTOR SEALING PRODUCTS USED THE WORLD OVER

SEALING PRODUCTS

RELIANCE V*S DRIVE

AN ALL-ELECTRIC ADJUSTABLE-SPEED DRIVE FOR ALTERNATING-CURRENT CIRCUITS . . .



Now makes available in economical form for sizes 1 to 15 hp. a proven principle of speed control long used for large units

You can do these things with this new Reliance Drive: (1) Apply power where you want it without intervening speed-changing devices . . . (2) Control speeds at any point to which a wire can be run, and do it from a speed changer no bigger than a pie plate . . . (3) Control starting and stopping from a small push-button station placed within easy reach.

Besides the advantages of wide speed ranges (12 to 1) and remote control you get other important features such as quick stopping, speed setting, safe speeds for threading and inching, ample starting torque for all conditions. All these are made possible at a lower price by the "packaged" V*S Speed Control Unit which is connected by three wires to the 3-phase a-c. power circuit. Of vertical construction, it takes little space and can be mounted anywhere.

Reliance Electric & Engineering Company
1079 IVANHOE ROAD **CLEVELAND, OHIO**

Birmingham, Boston, Buffalo, Chicago, Cincinnati, Detroit, Greenville (S. C.), Los Angeles, New York, Philadelphia, Pittsburgh, Portland (Ore.), St. Louis, San Francisco, Syracuse (N. Y.) and other principal cities.

DESIGNERS . . .
Please take note

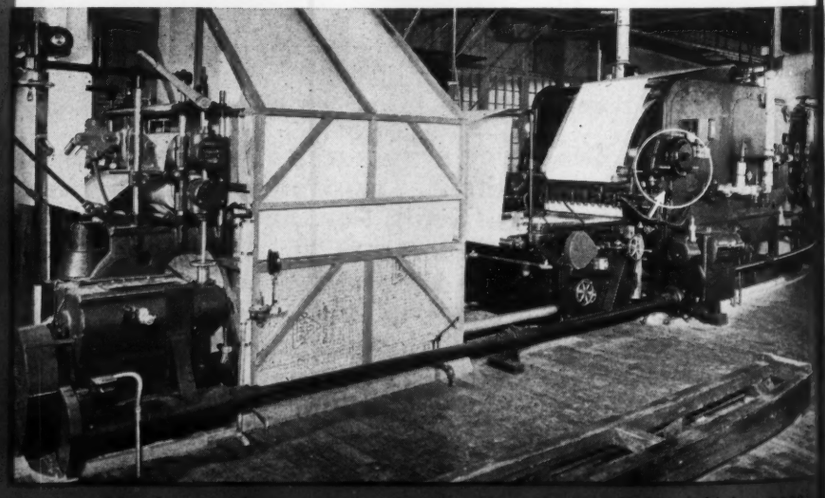
This new drive will help in "streamlining" your equipment by giving a direct, positive connection from the adjustable-speed motor to the machine. Speed adjuster and push-button take so little space that they can be grouped with other control handles for easy operation.

★ ★ ★

Produced by men who have specialized in adjustable-speed motor-drives for 34 years.

★ ★ ★

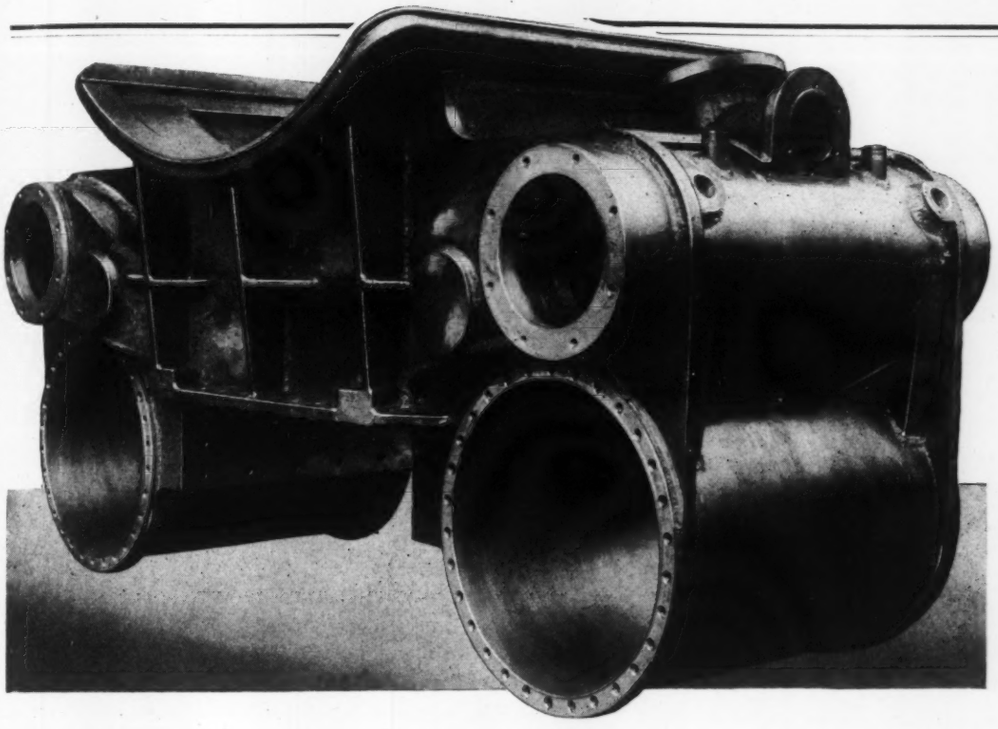
Get Bulletin 307 for details of the many desirable characteristics of this new drive.



Morrison Sanforizer equipped with a Reliance V*S Drive (7½ hp. 220-215 rpm.). This application emphasizes the ease of providing for remote control of starting, stopping and speed changing. Push-button and speed adjuster are indicated by arrow; speed control unit and adjustable-speed motor are at the entry end of the machine on the left.

RELIANCE A-C D-C MOTORS

Another "IMPOSSIBLE" ROLLED STEEL JOB



"IF you can weld that, you can weld anything" was the comment of a railroad official when shown plans for fabricating a complete locomotive cylinder of rolled steel.

To make a long story short, they did build this cylinder by welding—built it from sound rolled steel. The finished weight was 25%, or more than two tons, lighter than the conventional cast construction. The cost was about 24% less than that of the corresponding cast cylinder. If, on their first attempt, a railroad welding shop can build this most complicated part from wrought steel by means of welding, what is there in railroad construction that cannot be fabricated of wrought steel.

This cylinder has been giving entirely satisfactory service on a locomotive working on heavy hauls in mountainous territory—so satisfactory that there are now under construction several more cylinder units which are to be applied to locomotives in the same service.

This triumph of rolled steel construction follows closely on the heels of equally intricate jobs. A continuous spinning machine, for example, produced at half the cost of other types of construction for a rayon plant, sets new standards of precision and produces higher quality yarn. A roller leveler, given additional strength and rigidity with rolled steel construction, saves 50% in fabrication time, 15% in weight and 5% in cost. A massive stator frame for a vertical water wheel generator is produced direct from the drawings—with a consequent reduction in cost and time.

From the simplest sort of construction to the most complicated, rolled steel has to its credit outstanding examples of time and costs saved, of improved products . . . lighter, longer-wearing and better-looking.

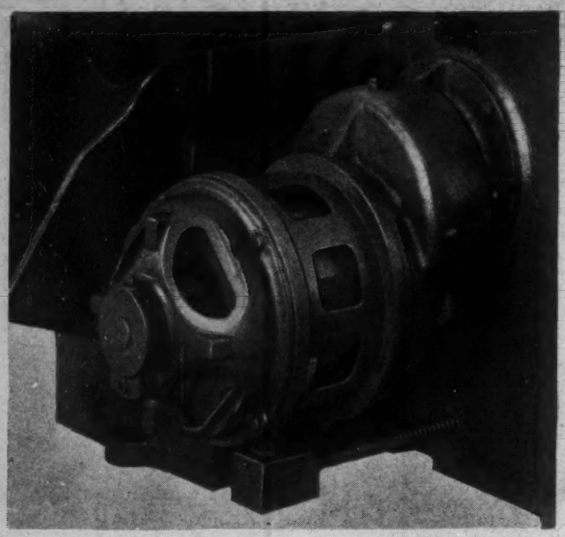
To designers and fabricators, foundries and welderies, we offer steels in widest range for rolled steel construction. Among them the special steels, U·S·S COR-TEN, U·S·S Abrasion Resisting Steels, U·S·S Carilloy Alloy Steels, U·S·S Heat Resisting Steels and U·S·S Stainless Steels. Here are steels with special properties for use in strategic spots—combined with one another, with castings or plain steels as the need dictates—to combat destructive forces and give equipment longer life. And our experience in putting these steels to work where they will best perform is yours for the asking.

CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
COLUMBIA STEEL COMPANY, *San Francisco*
TENNESSEE COAL, IRON & RAILROAD COMPANY, *Birmingham*
United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL

"STOCK" DRIVES
SAVE SPACE AND COST

MOTORS FOR BUILT-IN APPLICATIONS

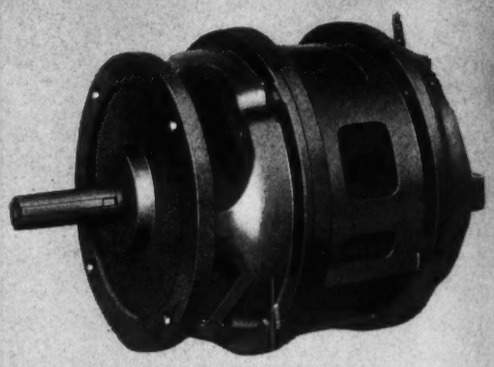


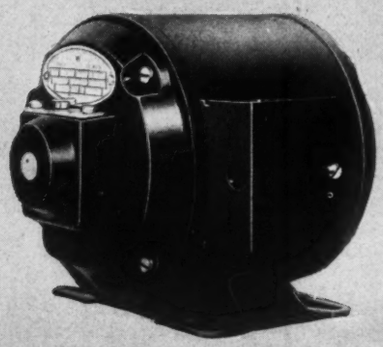
FLANGE MOUNTED GEARMOTORS

High-speed efficiency for low-speed drives—Westinghouse gearmotors. Select mounting to match requirements. Save space, add to appearance of machine, reduce maintenance costs.

FLANGE MOUNTED MOTORS

Wide variety of mountings permits selection of standard parts for assembly best fitted for the job. Can be supplied in enclosed type to seal against dust, dirt and moisture for unusually severe conditions.

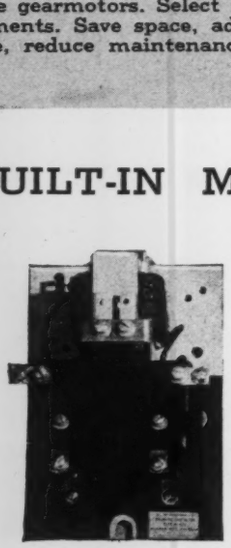




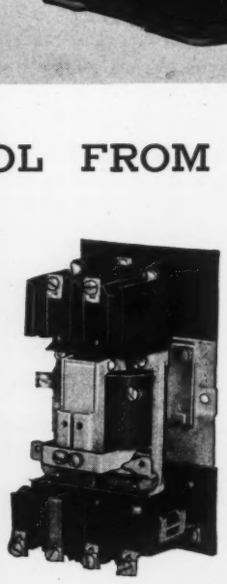
FRACTIONAL HORSE-POWER MOTORS

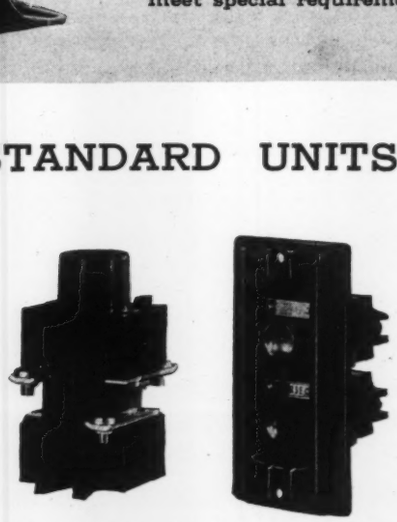
For any type of application requiring small motors such as auxiliary motions and cooling systems. Brothers in sturdiness, durability and dependability to large Westinghouse motors. Obtainable with sleeve or ball-type bearings. Protection against burnouts. Stock mountings to meet special requirements.

BUILT-IN MOTOR CONTROL FROM STANDARD UNITS



Across-the-line motor starters and contactor units, for practically all built-in applications, with motor protection and all circuit interlocking functions.



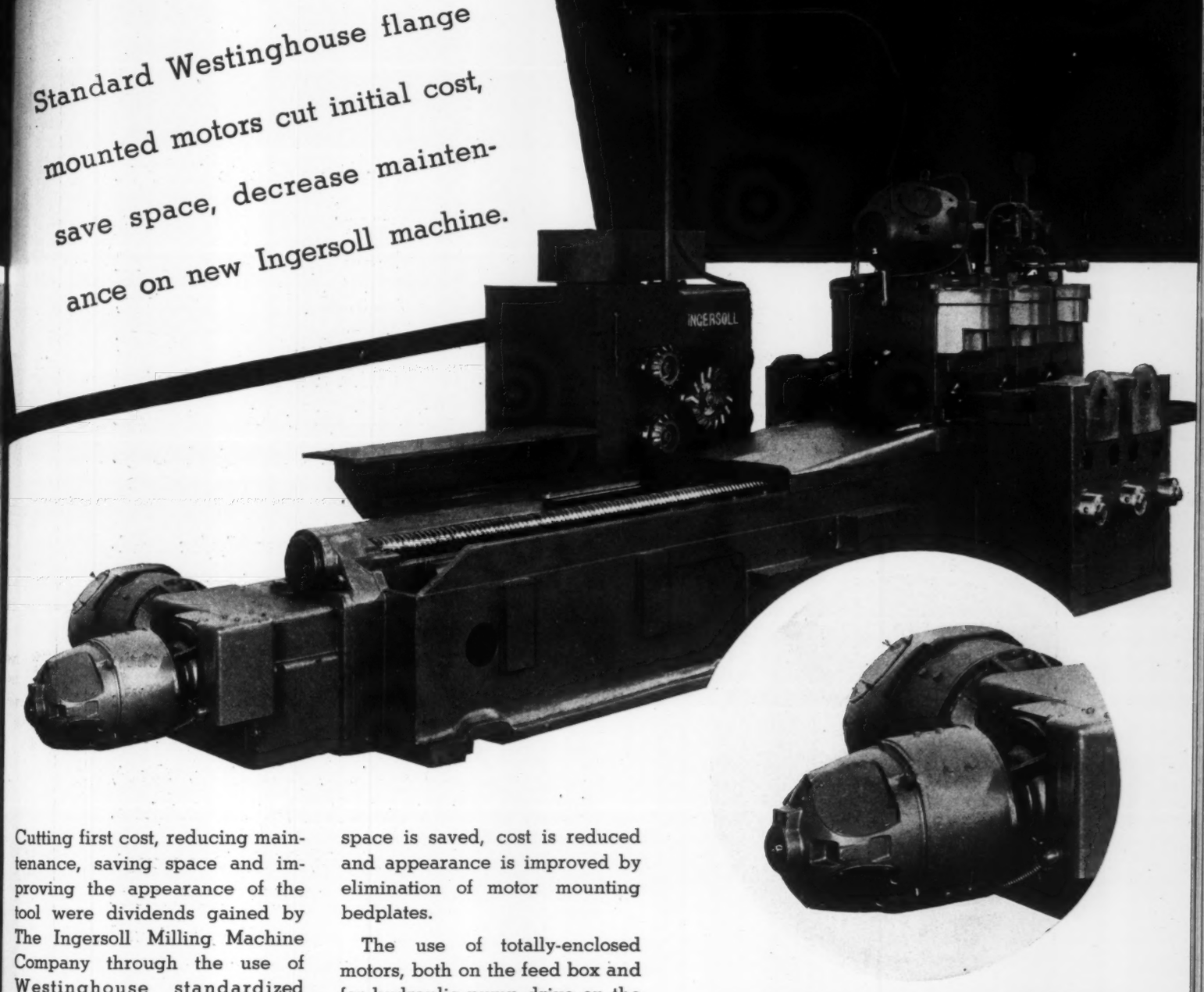


Standard push-button unit — for built-in applications, available for steel plate, surface, and flush plate mounting.

Westinghouse

WESTINGHOUSE ELECTRIC

Standard Westinghouse flange mounted motors cut initial cost, save space, decrease maintenance on new Ingersoll machine.



Cutting first cost, reducing maintenance, saving space and improving the appearance of the tool were dividends gained by The Ingersoll Milling Machine Company through the use of Westinghouse standardized drives on this copper bar scalping machine.

The differential feed box becomes a self-contained unit when equipped with flange mounted traverse and feed motors. This construction eliminates seals and bearings in the gear box since the drive pinions are directly mounted on the motor shaft extensions. With this design, floor space is saved, cost is reduced and appearance is improved by elimination of motor mounting bedplates.

The use of totally-enclosed motors, both on the feed box and for hydraulic pump drive on the carriage, insures protection from dirt and metal chips, with attendant maintenance advantages.

Our engineers are at your service for the solution of similar drive problems. Ask your local office for complete data, or write Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pennsylvania. Address Department 7-N.

J-90207

Westinghouse Standardized Drives on this machine include:

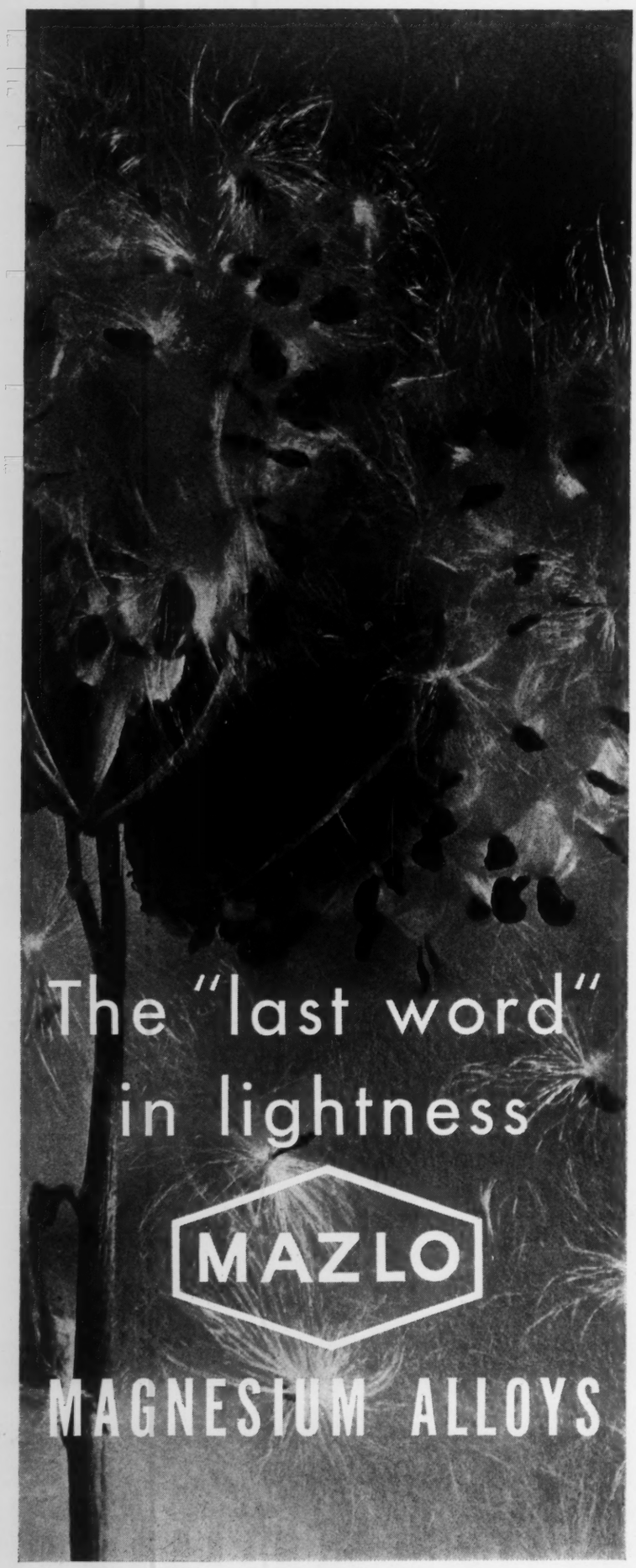
1 — 40 hp foot mounted main drive motor

1 — 7½ hp flange mounted rapid traverse motor

1 — 5 hp flange mounted feed motor

1 — 5 hp foot mounted fixture motor

Motors and Control



MAZLO is the name to know in Magnesium.

MAZLO means, first, a practical family of Alloys of Magnesium, lightest of commercial metals; Alloys with a range of physical and fabricating characteristics that make it economical to go *very* light.

MAZLO stands, second, for availability, for variety of commercial form, completeness of manufacturing facilities and experience in fabricating methods. Specifically: ingot, sand, permanent mold and die castings, extrusions, sheet, tubing, forgings, wire and ribbon.

MAZLO stands, third, for an engineering service which is realistic rather than promotive, matured by years of association with both the technical and economic aspects of achieving lightness.

MAZLO engineering, Mazlo facilities, Mazlo Magnesium Alloys are at your service. *Sales Agent:* Aluminum Company of America, 1703 Gulf Bldg., Pittsburgh, Pa.

MAZLO

Reg. U.S. Pat. Off.

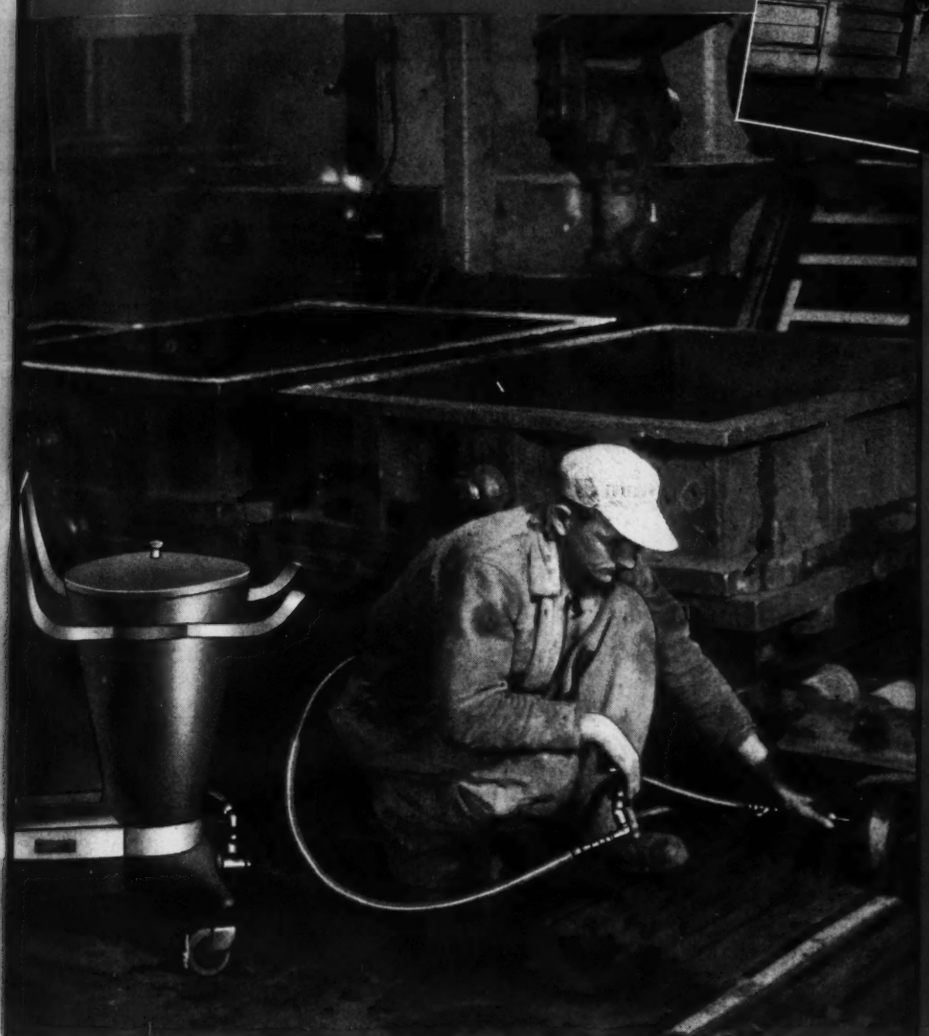
AMERICAN MAGNESIUM CORPORATION

HEAT... WATER... SAND...

ALL FOUNDRY LUBRICATION HAZARDS LICKED BY ALEMITE

REG. U.S. PAT. OFF.

Lubrication Equipment!



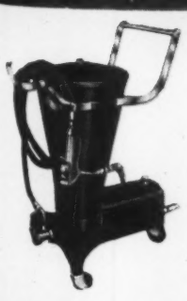
James B. Clow & Sons Say: "Write Your Own Testimonial about Our Experience with Alemite Equipment"

WHENEVER you are designing machines which must stand up under exceptionally difficult lubrication conditions—*such as the heat, water, and sand always encountered in foundries*—be sure your specifications include an Alemite Lubrication System!

Industrial maintenance men know Alemite—have known it for years. They know that *Alemite Systems are found on best known machines*, used as standard equipment by thousands of leading machinery manufacturers—and they know how to take care of machinery so equipped. When you build Alemite lubrication into the original design of your machines, you *are making it easy for the user to lubricate* correctly. You are helping him safeguard important bearings. You are insuring long life and dependable service and saving yourself service calls and adjustments.

Remember—Alemite Lubrication engineers are always glad to consult with you on the solution of lubrication problems. Their time and experience *are yours for the asking*, without obligation. Write today for your FREE copy of our new industrial catalog!

ALEMITE REG. U. S. PAT. OFF. *A Division of Stewart-Warner Corporation, 1804 Diversey Parkway, Chicago, Illinois. Stewart-Warner-Alemite Corporation of Canada, Ltd., Belleville, Ontario*



Model 6515 Air-Operated Alemite Power Gun

Holds 40 pounds viscous, fibrous, or plastic lubricant; develops 33 times air pressure used. Easily portable; exclusive helix arm and worm prevents air pockets; comes complete with 10-ft. hose and adapters.

Model 6700 Alemite High Pressure Pneumatic Barrel Pump

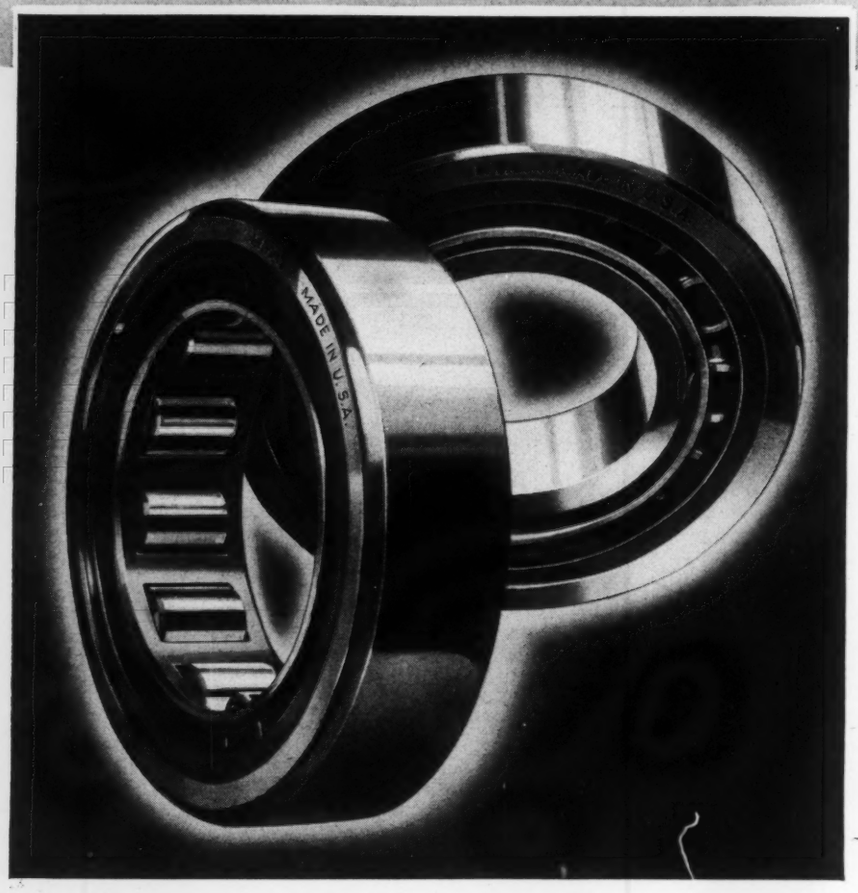
Screws directly into bung hole of 400-lb. grease drum; designed for volume high pressure lubrication of large bearings. Available in different piston ratios for 600 to 7000 lbs. pressure.

Model 6524 Alemite Electric "Rock Crusher"

Exclusive patented helix arm and worm positively prevents air pockets! Holds 40 lbs. lubricant—fibrous, plastic, or viscous; develops pressure of 5000 lbs. per sq. inch. Easily portable.

WORLD'S LARGEST MANUFACTURER OF LUBRICATION PRODUCTS

BUILT FOR *Speed and Endurance*

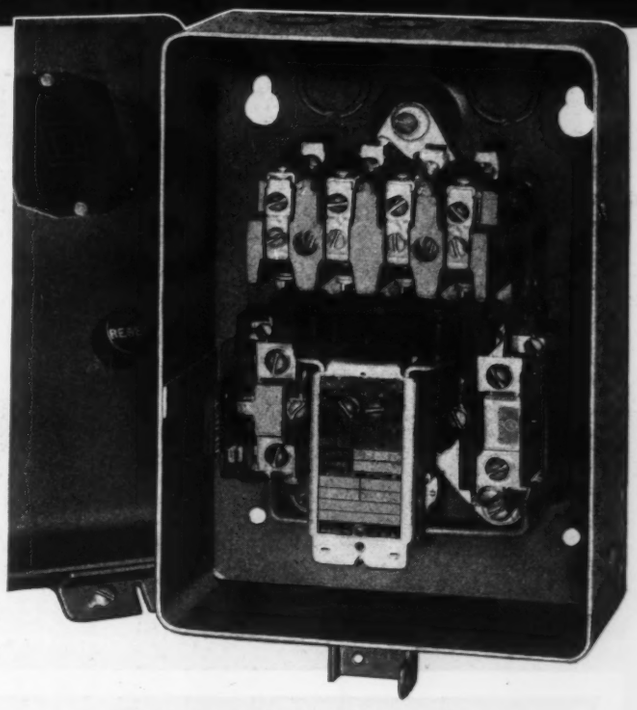


In the smooth functioning of mechanical equipment the design engineer knows well the importance of Hyatt Roller Bearings . . . how efficiently they operate . . . conserve power . . . obviate wear, attention and replacement. All made possible by the qualities of speed and endurance we build into them. And each succeeding year as they grow greater in performance they are used in greater numbers. Where and when can we serve you? Hyatt Bearings Division, General Motors Sales Corporation, Harrison, New Jersey; Detroit, Chicago, Pittsburgh and San Francisco.

HYATT *Roller Bearings*

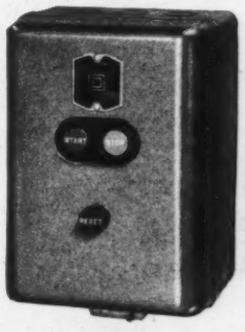
Announces

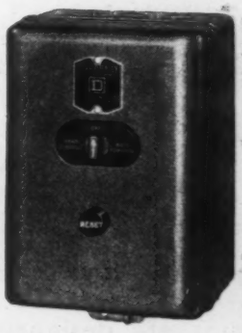
A SMALLER AUTOMATIC STARTER FOR ALTERNATING CURRENT MOTORS



● The new Size O, Type R, is a smaller vertically operating starter in the Class 8536 line. It meets the demand for an automatic starter for the smaller sizes of polyphase and single phase motors. Maximum polyphase ratings are 2 H. P., 220, 440, 550 Volts; maximum single phase ratings are 1 H. P., 110 Volts or 1½ H. P., 220 Volts.

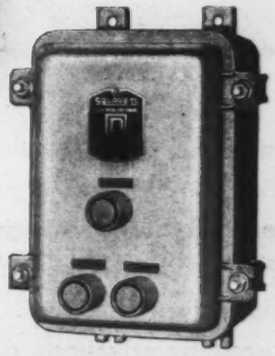
This starter has a vertically operating magnet, double break silver contacts and thermal overload relays. It is offered with general purpose, dust-tight, water-tight or Class II, Group G enclosures; also as a combination starter with either disconnect switch or circuit breaker; also in the reversing type.



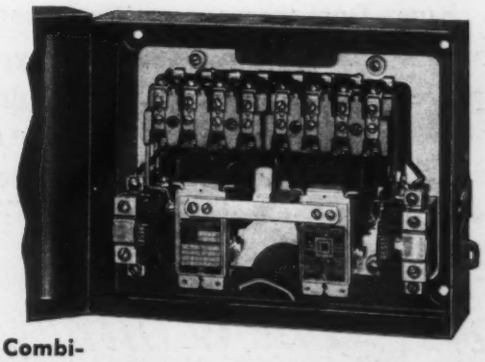


(Extreme Left) Start-Stop push buttons in cover

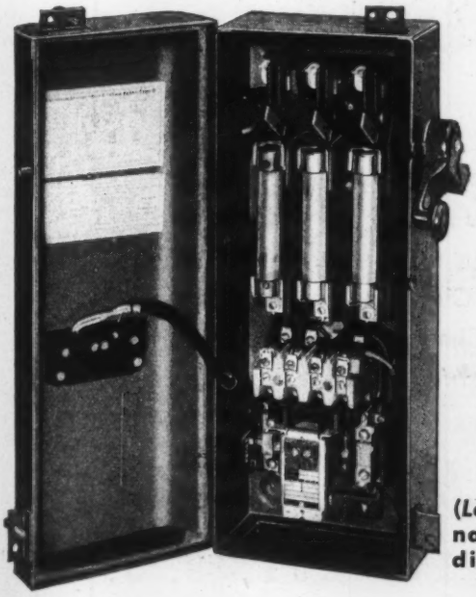
(Left) Three-Way selector switch in cover



(Above) Water-tight, dust-tight or Class II, Group G enclosure



(Left) Reversing automatic starter



(Left) Combination with disconnect switch

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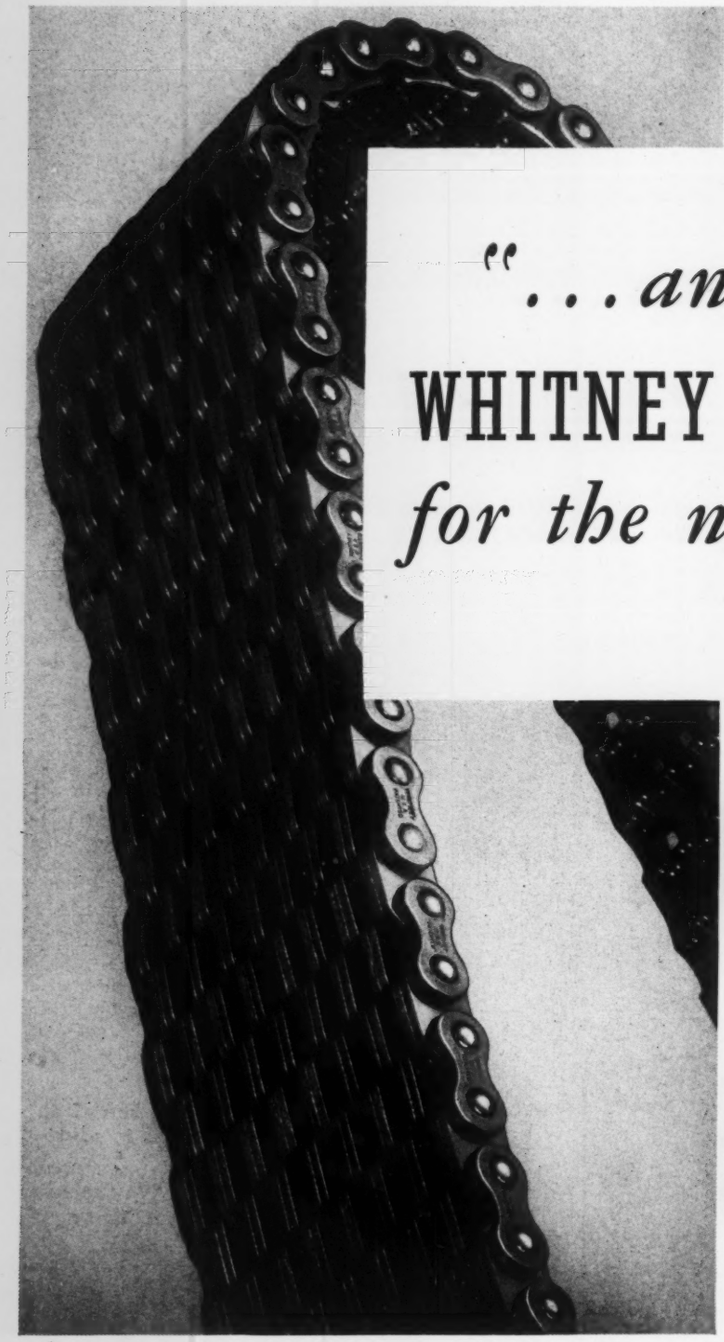

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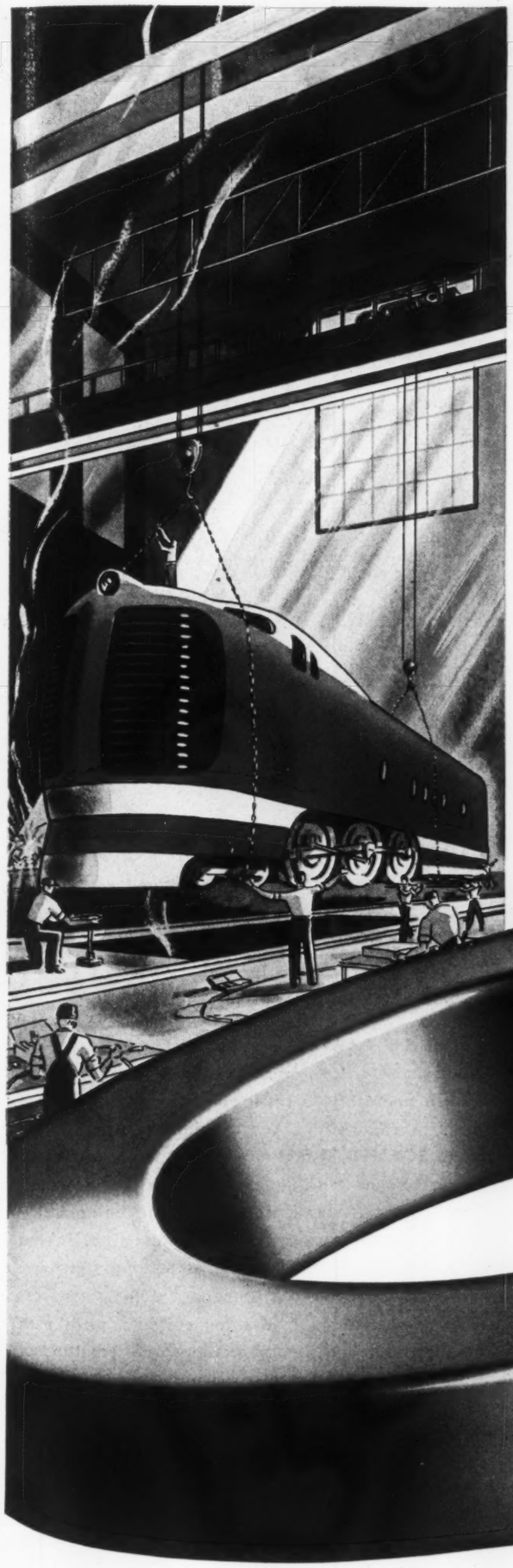

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of Helical Spring Washers keeps every bolt tight!

Control levers are set! A switch clicks! A locomotive is raised as if it were a toy engine! One loose bolt in the crane could cause disaster!

Crane designers, in common with designers throughout industry, know they can *depend* upon Helical Spring Washers to keep bolted parts tight. The reason—*long range Live Action*, an *exclusive* feature of Helical Spring Washers, maintains constant pressure against the threads—immediately compensating for any play or looseness.

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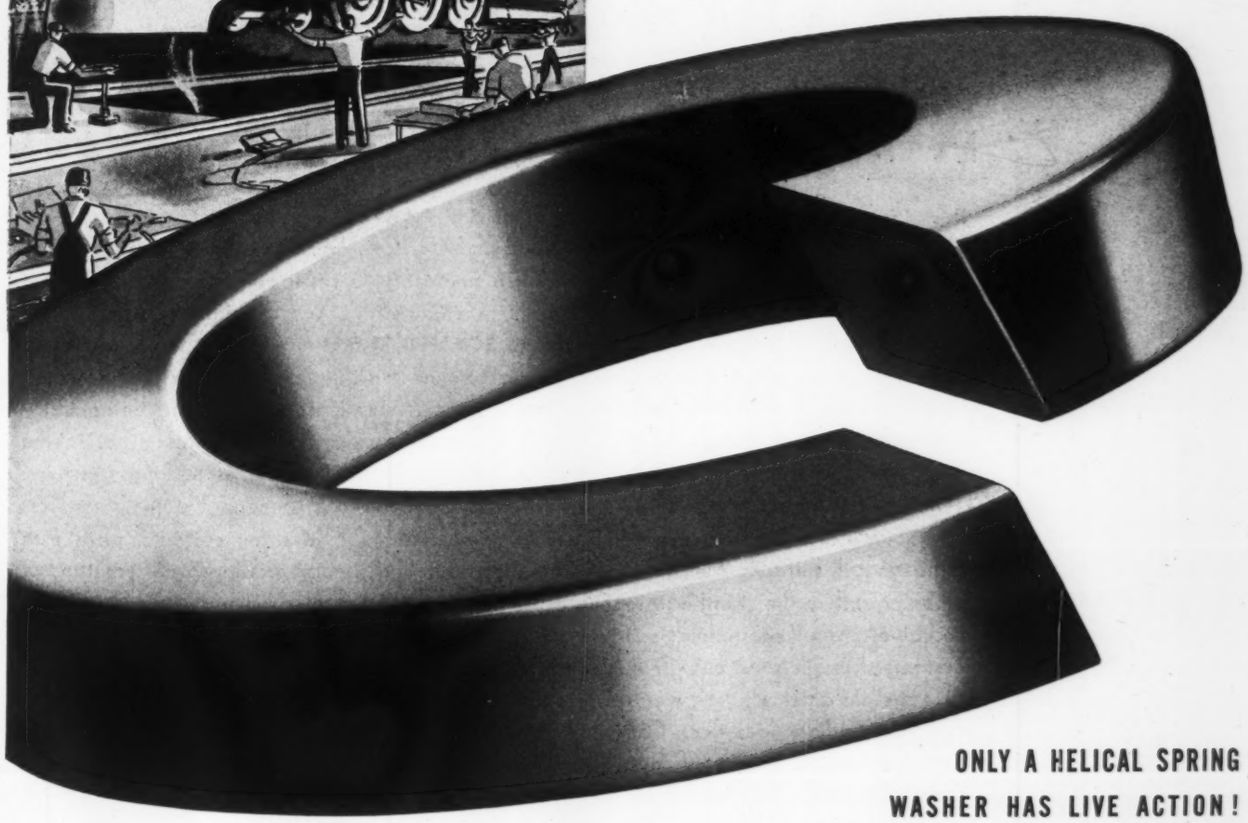

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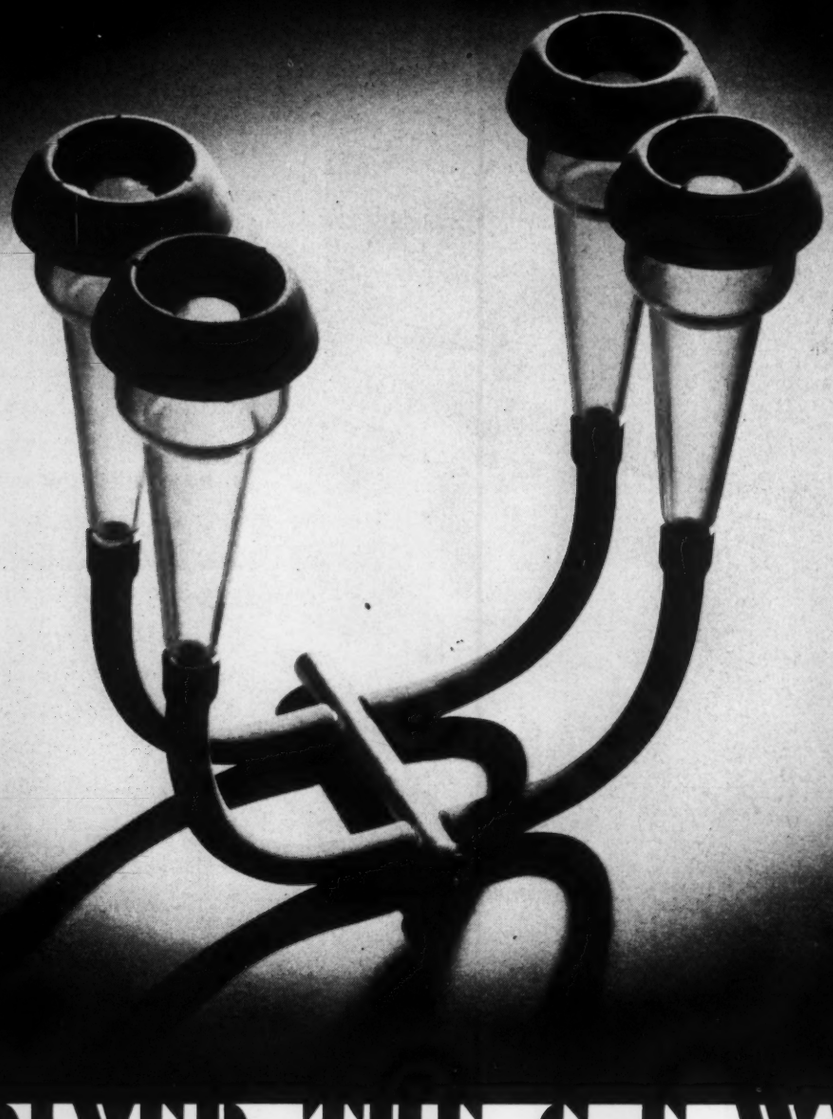
PLASTICS PROBLEM NO. 4



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PARTS: Textolite transparent teat cups. **USE OF PARTS:** Used on the Clean-Easy-Portable Milker, made by the Ben H. Anderson Mfg. Co., Madison, Wisc. **CUSTOMER'S PROBLEM:** A material replacing metal was necessary to resist corrosion caused by the lactic acid in milk, and to withstand a daily washing with a lye disinfectant. The difficult shape offered an unusual molding problem. **SOLVED THE G-E WAY:** Various grades of Textolite were tested by the customer to determine which grade provided the required characteristics. It was found that a pure resin plastics was most suitable and being transparent it also gave the Anderson Co. one of its most important sales points—that is, the dairymen can watch the milking operation and see that the teat is milking properly. Another requirement was smoothness for easy cleaning. As General Electric supervises the making of all customer molds it was a simple matter to give the customer parts with extra-smooth surfaces. Finishing, after molding, required special facilities and a method of cleaning unlike the standard procedure. A wide range of plastic materials offering various combinations of properties; self-contained modern tool rooms with close supervision of customers' molds; and complete facilities that easily permit out-of-the-ordinary methods to give the customer what he wants, are only three of the many phases of General Electric's custom molding facilities. Combined they comprise THE G-E WAY—your way to better service and quality in plastics. For complete information, write Section M-89, General Electric Co., Plastics Department, One Plastics Avenue, Pittsfield, Massachusetts.

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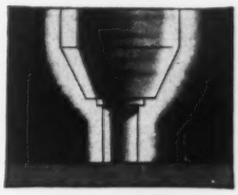
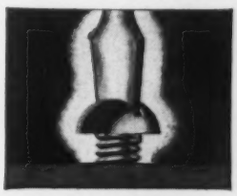


1 First . . . Drill—



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3 A Perfect Fit—

4 Replaceable with Ordinary Machine Screw

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Because Shakeproof Thread-Cutting Screws actually cut their own threads, a snug, tight fit for every screw is certain. The thread-cutting action is produced by the patented slot with serrated cutting edge, plus a special hardening process that makes each screw a practical tapping tool. Expensive tapping operations are eliminated —production is accelerated and better product performance is achieved. Test Shakeproof Thread-Cutting Screws on your product —write for free samples today!

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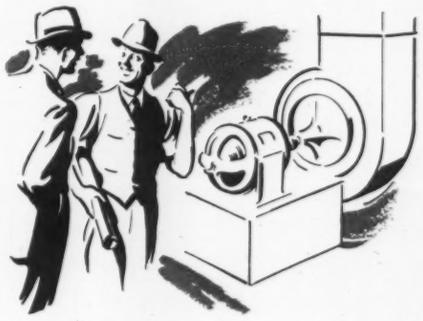
Recommend a bearing for a crusher installation in a cement mill! . . . for the shaft of a high-speed centerless grinder! . . . for the retractable wing tip floats of a big seaplane! *And don't make a mistake,* for ball bearings can be nearly as tough as diamonds when they're properly specified and applied; nearly as fragile as orchids when they're not. They're about as far from the "nut and bolt" class of parts as you can get.

That's why *practical experience* is so important a requirement of the Fafnir sales engineer. Take him as a group, and he's a junior Methuselah with 318 years of intensive field experience, able to hop a train toward any industry's pet problem and — from the time he arrives — make sound, helpful recommendations on the bearings that will solve it. Or



picture him in your mind as an individual typical of the group. You'll get a friendly, seasoned veteran with 13 years of ball bearing experience to his credit. No mere textbook engineer, but a man who has just washed the grease of the last job from his hands when he tackles yours. A specialist, he knows his end of the bearing business to a "T," just as his associates know theirs.

This experience of his is a fluid thing. He is constantly storing it up, constantly drawing upon it. And something more tangible than experience is stored up. For it is the Fafnir creed to make his new developments available — as soon as they are proved practical — in the widest possible range of new standard bearing types and sizes.

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Fafnir production is not limited to a few types of bearings to the exclusion of others. Rather, the balanced line of Fafnir Ball Bearings includes every type and size of radial and thrust bearing, wide inner ring bearing and transmission unit to provide the most complete line in America.

Manufacturers who standardize on Fafnirs for original equipment or replacement enjoy the benefits that come with meeting every ball bearing demand from a single source of supply.

Ball Bearings

THE BALANCED LINE . . . MOST COMPLETE IN AMERICA

Topics

THREE recent developments in materials merit the close attention of designers. Full significance of the development of a better process for making *buna,* artifical rubber, will not be assessed until it is made commercially and uses are found for it. But the fact it probably will sell in direct competition with natural rubber, has all the latter's desirable characteristics plus twice as much resistance to abrasion, heat, oxidation, acids and alkalis, makes it virtually certain to have important effects on the rubber market. Methods for making *buna* in Germany and Russia have succeeded only at excessive cost, which has been deemed worthwhile because of those nations' desire for economic and military self-sufficiency. The new process, announced by Universal Oil Products Co., Chicago, aims at the same key substance as do those in Germany and Russia. This substance is the hydrocarbon, butadiene. Germany requires much processing from coal and limestone through calcium carbide and acetylene gas to butadiene. Russia begins with costly butyl alcohol. "Raw" material for Universal's process is butane gas, a component of natural gas and refinery gas produced in gasoline cracking. It is very plentiful and dirt cheap—two cents a gallon. One inexpensive step converts butane to butadiene, which is subsequently easily polymerized and processed into synthetic rubber. Heated to 1000 degrees Fahr., butane is passed over solid catalysts of the same temperature at atmospheric pressure. Two hydrogen molecules are detached and butadiene and hydrogen emerge from the machine. Dr. Gustav Egloff, director of research for Universal, told the editors several chemical companies are interested in installing a butadiene-making process under license from Universal. The company is now designing a commercial unit and American-made *buna* is expected to appear on the market within a year.

♦

INCREASED commercial use for glass became another potentiality of the near future with the announcement by Corning Glass Works of an experimental glass which resists temperature changes because of its low coefficient of expansion — .00000078. Like Pittsburgh Plate Glass' Herculite, Corning's new glass attains its remarkable characteristics through different heat treatment. After being mixed, melted and molded by ordinary methods, the glass is heated and dissolved 35 per cent by nitric acid. Subsequent reheating shrinks it 13 per cent and it is then resistant to temperature changes. To show its stability, a slab of the new material was recently placed on a red-hot metal ingot while ice was put on top of it. It failed to break.

♦

HEAT treatment is also responsible for putting metallurgy in the materials limelight. Research by U. S. Steel Corp. has clarified understanding of steel reactions when cooling after heating, and a new treatment, austempering, makes it possible to combine hardness and ductility to an unusual degree in ordinary steels. Purpose of rapidly quenching hot worked steel is to force transformation of austenite, the crystal structure characteristic of steel heated above its critical temperature, to martensite, the hard, brittle structure formed at low temperatures. Because transformation resulting in a soft though ductile product will begin at around 1000 degrees Fahr. unless cooling is very rapid, martensite usually is tempered by reheating to around 600 degrees Fahr. The austempering process, as reported by Arthur D. Little Inc., involves only quenching steel at a temperature near the tempering zone—600 degrees Fahr.—and holding it there until the transformation is complete. Minutes and even hours may be necessary, instead of seconds. The holding period depends on the steel and must be determined for individual steels of varying composition. Stresses of quenching which cause submicroscopic cracks impossible of removal by tempering, are avoided. One very important aspect of this research is the fact it changes the outlook on alloys in steels. Alloys retard the onset and completion of the austenite transformation, hence alloy steels can be heat treated in sections larger than those of ordinary steels which cannot be quenched fast enough to prevent softening of the interior. It is claimed, however, that austempering gives unalloyed steels in sections less than ⅝-inch the principal advantages of a number of alloy steels.

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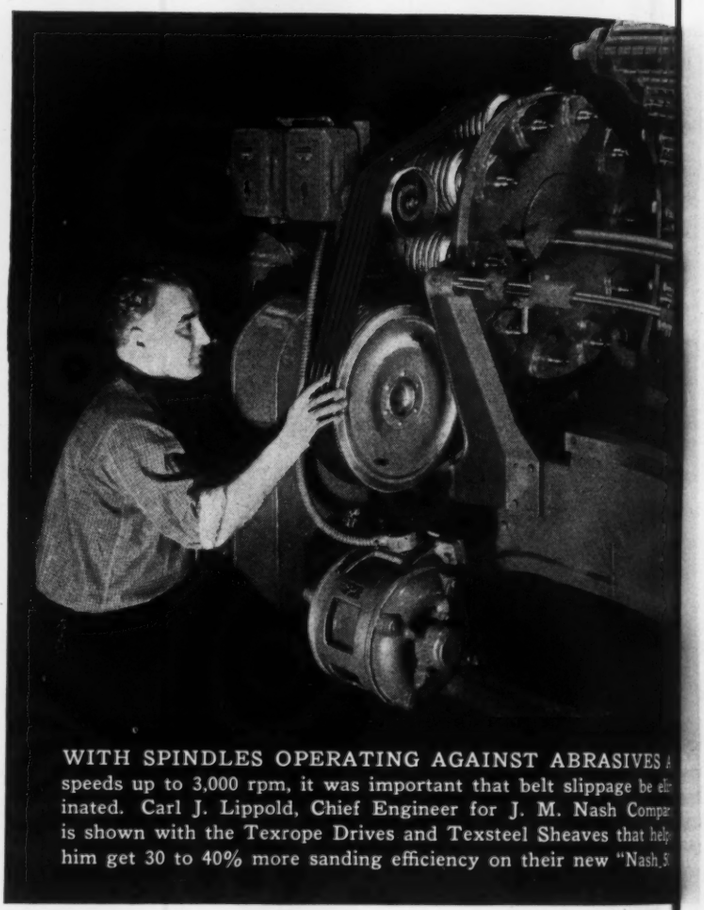

WITH SPINDLES OPERATING AGAINST ABRASIVES A speeds up to 3,000 rpm, it was important that belt slippage be eli inated. Carl J. Lippold, Chief Engineer for J. M. Nash Compa is shown with the Texrope Drives and Texsteel Sheaves that help him get 30 to 40% more sanding efficiency on their new "Nash 5

When an equipment manufacturer switches to Allis-Chalmers Texrope Drives and gives his customers 30 to 40% more efficiency on the same machine . . . that's important news for *all* equipment manufacturers!

Yet this amazing increase in efficiency is what the J. M. Nash Company, Milwaukee, got when they equipped their new "Nash 50" Automatic Turning Sander with Texrope Drives!

Gets Greater Efficiency!

Here's what Carl J. Lippold, Chief Engineer and Designer for the J. M. Nash Company, says —

"In designing our new machine, we went to Texrope Drives to solve a former slippage problem. We now find after repeated tests under many varying conditions that the new machine has 30 to 40% greater sanding efficiency than before we used Texropes. As a result of this new efficiency factor, we expect larger sales than ever before."

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Join the J. M. Nash Company and the hundreds of other equipment manufacturers who are turning to Allis-Chalmers Texrope Drives to give their products better performance . . . greater efficiency . . . more sales appeal!

Equip your machines with the drive that's 98.9% efficient . . . that doesn't jerk . . . doesn't slip . . . and gives the long-life service your customers want!

Get the whole story on Texrope Drives and the rest of the fast-selling Texrope transmission line. Call the district office near you. Or write to Allis-Chalmers direct. A trained transmission engineer will be glad to cooperate with you . . . help you solve your equipment problems.

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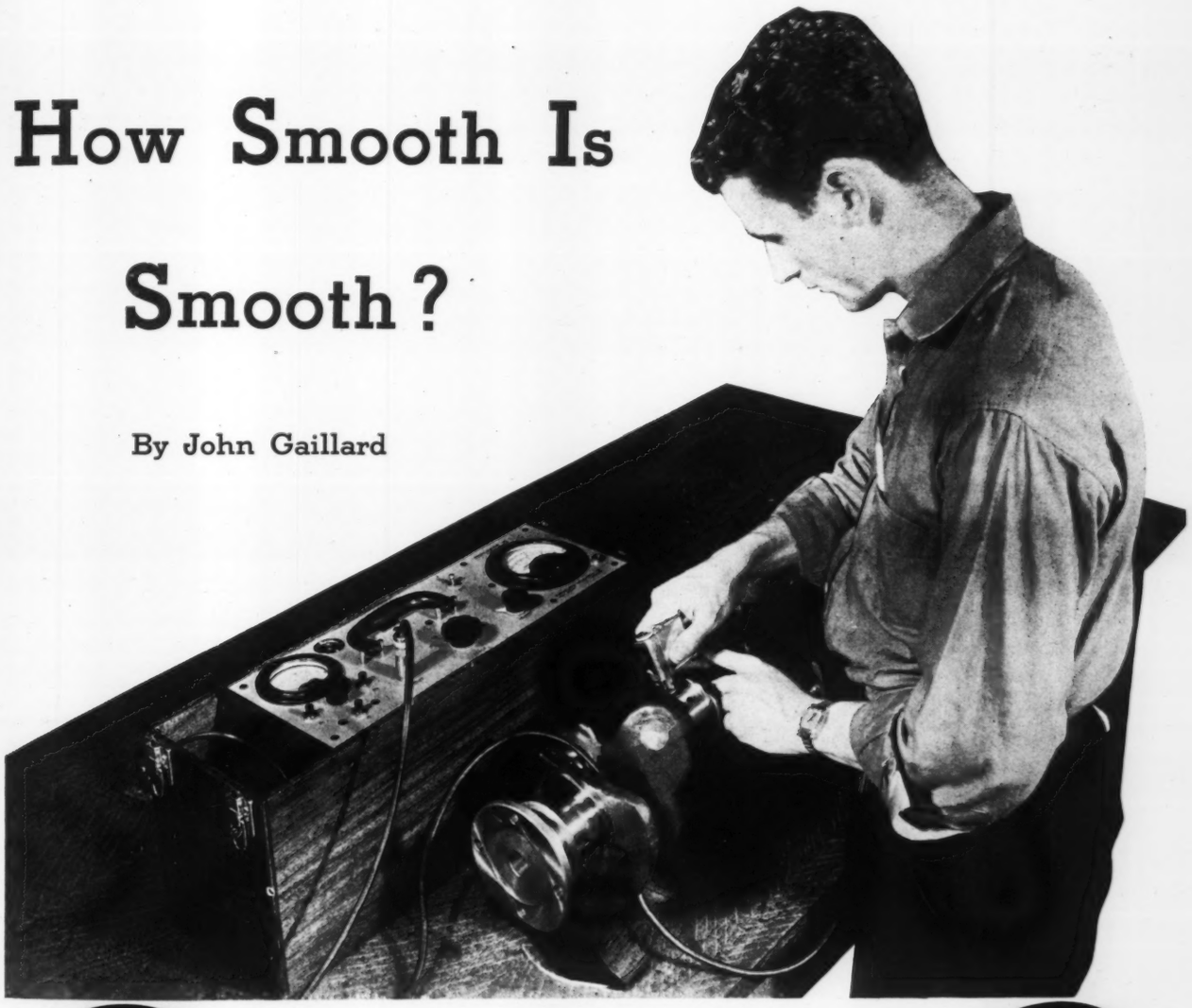
MACHINE DESIGN

How Smooth Is Smooth?

By John Gaillard



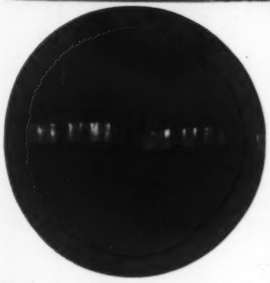


Fig. 1 — Top — Checking bearing surface with profilometer. Fig. 2—Surface profile of brass turned with diamond tool

AS DESIGN technique becomes more refined, the need for increasingly detailed specifications for the component parts of a machine becomes more important. Thus, the need has arisen for clarification of the concept "surface quality." Its definition, measurement and classification are of direct interest to the machine designer. He must determine the kind of surface quality a given part should have and specify

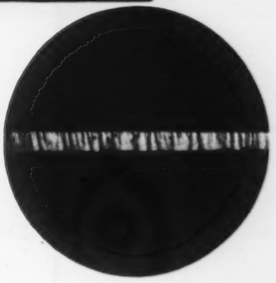


Fig. 3—Profile of ground steel. Height of surface roughness is 52 microinches, maximum

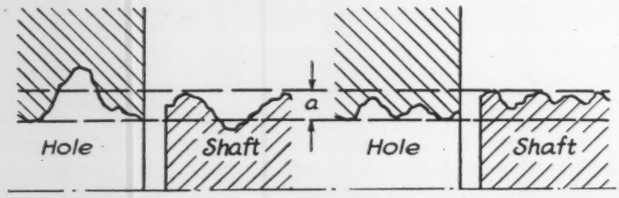


Fig. 4—Comparison of actual interference for the same measured interference a for different roughness of hole and shaft surfaces. Surface quality affects wear, holding power

this quality on the drawing of the part.

Surface quality involves a number of physical and chemical properties of the boundary zone between a solid body and its surroundings. However, the machine designer is interested primarily in the relative roughness or smoothness of a surface and generally understands the term "surface quality" in this sense.

A ground and lapped surface without visible scratches has a higher quality than a rough-turned surface whose toolmarks can be seen and felt. While distinction between such extremes is an easy matter, we are not able to judge accurately the relative qualities of surfaces in all cases. For example, one ground surface may be glossy and yet have deeper scratches than another which is duller but actually has a better surface quality.

Surface Affects Strength

Many methods of measuring the actual roughness of a surface have been developed. One such method is shown in *Fig.* 1 where a profilometer is being employed to measure a crankshaft bearing surface. This instrument is electrically operated and employs a point of incredible sharpness to explore the surface. Its variations are shown on the dials in the box.

In *Fig.* 2 is shown a surface profile of brass turned with a diamond tool and a feed of .0024 inch. The maximum height of surface roughness measures 400 microinches. Likewise, a profile of steel with a ground surface is shown in *Fig.* 3. In this case the maximum height of roughness is 52 microinches.

A fit between a shaft and a hole as illustrated in *Fig.* 4 may require special care in regard to surface finish

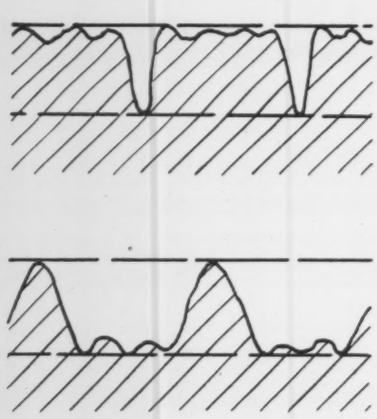


Fig. 5—Character of two surfaces with same maximum height of roughness

of the parts. This applies to running fits as well as press fits. In the former, surface quality affects friction and wear. In the latter, it affects the holding power of the assembly.

Wear of moving parts increases with surface roughness because there is more chance for irregularities on one piece to tear off particles from the other. The necessity of letting new machine parts "run in" to smooth each other is now often eliminated by giving them a better initial surface.

Surface quality also affects friction between fluids and the conduits in which they flow. The time may come when the quality of the internal surface of a pipe line will be specified just as well as its inside and outside diameter. The effect of surface quality on skin friction is an important matter in high-speed modern airplanes.

The strength of machine parts is influenced by surface quality—the deeper a scratch, the more easily it becomes a starting point for a crack gradually leading to fracture. Not only the performance, but also the appearance of a machine may call for a certain quality of surface to make it attractive to the prospective customer.

Designers face two primary questions in regard to a given machine part. One is: "What surface quality does this part require?" and the other: "How can this quality be specified on the drawing so that others are able to produce it?"

The former question must be answered on the basis of experience or, if a novel problem arises, by research. To answer the second question, a method of expressing surface quality in terms of measurement must be evolved.

Efforts to Define Surface Quality

In the absence of a basis of measurement, some companies have given the designer and other interested parties guidance by establishing sets of samples of commonly used surface finishes, each designated by a name or symbol. Sets of such samples in different departments—such as engineering, manufacturing and inspection—furnish a common basis of comparison, at least within one company. However, they do not permit a direct comparison between, say, the "mirror" grinding finish of one firm and the "super" or "ultra" finish of others.

To some extent a surface quality may also be specified in terms of instructions as to how it should be produced. The designer may know that a given number of passes through a grinding machine and the use of grinding wheels of a given type, with definite speeds and feeds, will lead to the desired result. However, by thus specifying the finishing operation in detail, the designer excludes any other satisfactory method of producing the required surface. This has a disadvantage because those responsible for the surface finish should have the greatest possible freedom in choosing

the method. Otherwise, higher production costs are involved simply because the lowest-cost process available could not be applied.

Refinement in machine design has led to a search for a method of measuring surface roughness. If surface roughness can be expressed by a numerical value, finishes can be directly compared—even though produced by different methods—and specified on drawings by means of standard symbols.

What shall be the basis for measuring surface roughness? Obviously, the frequency and depth of the surface irregularities are the main items to be considered. The difficulty lies in the fact that roughness is not a simple concept, such as length or weight. Neither the frequency, nor the depth of surface unevennesses alone determines roughness. On the contrary, it is a collective characteristic which depends on the condition in each of the points of the surface area under consideration. For instance, *Fig.* 5 shows two surfaces

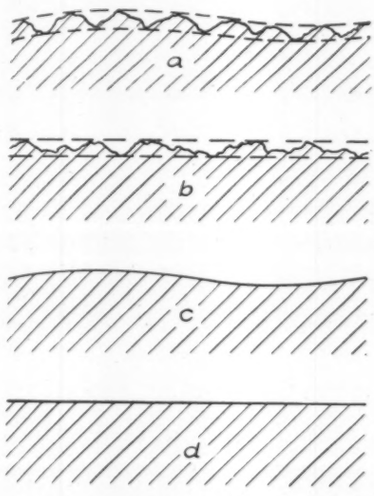


Fig. 6—Four combinations of shape inaccuracies and surface irregularities: (a) wavy and rough; (b) flat and rough; (c) wavy and smooth; (d) flat and smooth

with the same maximum height of unevenness. Therefore, any factor used to indicate surface roughness must be the result of the integration of a number of measurements extending through a certain zone.

In considering how wide this zone should be, we must first distinguish between two different kinds of deviations from the ideal shape of a part—inaccuracy of the general shape, and surface irregularities. Four different combinations of the two kinds of deviations are shown in *Fig.* 6 as they may occur in a workpiece with a nominally flat surface.

Where inaccuracy of shape ends and surface unevenness begins, is a matter of agreement. Schmaltz, one of the foremost experts in this field, has proposed that a square with a side of one millimeter be considered, all ups and downs falling within this square being counted as surface roughness and all surface "waves" exceeding the square, as shape inaccuracies.

To translate this into a single numerical value, the proposed American Standard for surface roughness specifies that the root-mean-square deviation of the

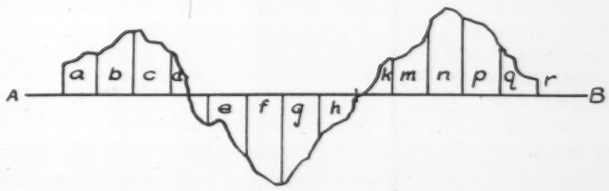


Fig. 7—Determination of root-mean-square of enlarged surface profile

profile shall be determined. If in *Fig.* 7, the line *AB* represents the average height of the profile measured from a reference line, and the deviations *a, b, c,* etc., from *AB* are measured in *n* points located at equal distances on *AB,* the root-mean-square deviation *S* of the profile is expressed by the formula:

$$S = \sqrt{\frac{a^2 + b^2 + c^2 + d^2 + \ldots.}{n}}$$

The unit in which *S* is expressed is the microinch, or one-millionth part of an inch.

If the factor *S* is adopted as a measure of surface roughness, we can specify on a drawing the requirement that for a given workpiece *S* shall not exceed a given value. On this basis, every manufacturer could establish a series of standard classes of roughness for his own use. However, it is better to establish a general classification comprehensive enough to be acceptable to the entire industry. Non-essential differences between roughness classes adopted by individual firms are then avoided and the problem of matching surface qualities applying to parts made in different plants is simplified.

Determine Range of Requirements

In establishing a series of roughness classes it is necessary to determine first the extreme range of requirements and second, the gradation of classes within this range. Because the total requirements of industry vary widely, the factor *S* may range all the way from ¼-microinch (0.00000025-inch) for highly polished finishes, to 0.063-inch, or about a quarter million times the former figure, for roughly finished parts. Between these extremes are, for example, surfaces produced by fine finishing operations, such as turning with a dia-

(*Concluded on Page* 82)

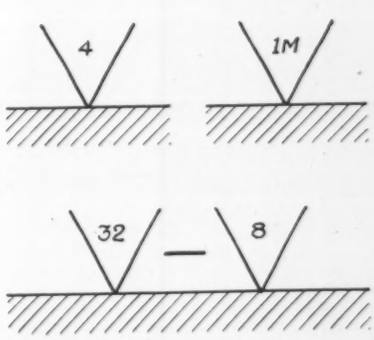


Fig. 8—Method of indicating surface roughness on drawings. Upper method shows maximum roughness. Lower shows maximum and minimum limits

Scanning the Field FOR IDEAS

Pressure Doubles Automatically

OBTAINING sufficient braking pressures on hydraulic systems with limited motion of brake pedal is a problem for heavy vehicles. Many proposals have been made for devices to take up slack with a large volume of fluid and then apply the desired pressure with a relatively short movement of the foot pedal. In some instances, the change-over from the first charge to the braking pressure could not be controlled, with the corresponding result that the brakes were applied violently.

The booster illustrated in *Fig.* 1 is so designed that the cycle of operation is automatic and controlled by fluid pressure from the master cylinder. Developed by the Vickers Mfg. Corp., the booster may be adjusted to pull up the slack in the lines to a desired point before applying high pressure. This pressure is so controlled that no noticeable fluctuation is obtained.

Two coaxial cylinders of a 2:1 area ratio fitted with a spring return piston provide the changeover in pressure. This piston has rubber hydraulic packings on both the large and small ends. On the end of the high pressure cylinder is a cast cage and fluid outlets containing a spring-loaded combination port shift valve and fluid metering pin.

Spring tension on the metering pin is adjustable to any desired tension. When pressure is applied to the large end of the booster piston, movement forward is prevented by the metering pin, which by means of a rubber packing seal prevents fluid from being forced from the high pressure cylinder. The brake shoes are set against the drum with an initial low pressure. Further pressure forces the metering pin out of the high pressure cylinder and automatically shifts the ports to apply doubled pressures.

Thus very little travel of the brake pedal is required to provide high pressures because the system has been precharged from the low pressure cylinder. Should the booster fail to operate for any reason, the brakes are applied with normal pressure.

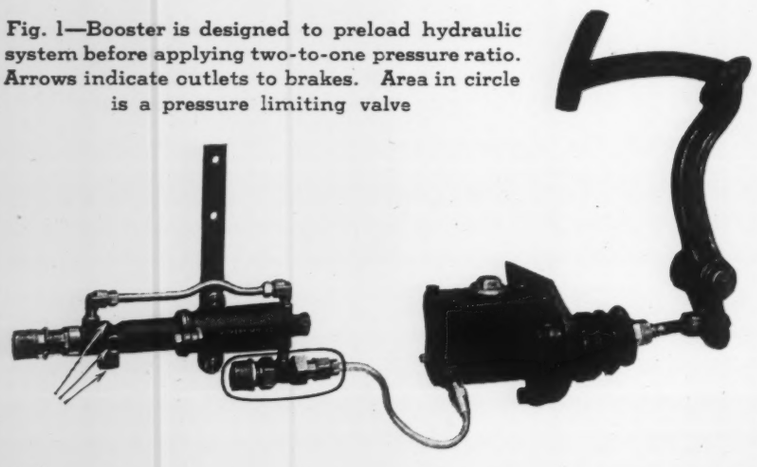


Fig. 1—Booster is designed to preload hydraulic system before applying two-to-one pressure ratio. Arrows indicate outlets to brakes. Area in circle is a pressure limiting valve

Solenoid Tunes Radio

SOLENOID-OPERATED pushbutton control on the new Crosley radios requires only a light touch for station turning. In addition the method of setting up the buttons on various stations has been simplified. Stations are automatically turned by each individual key, no locking screws being necessary.

When a button is depressed, a quick-acting switch makes contact supplying power to the solenoid coil. At the same time an adjusting screw is pushed down permitting a hook on the end of the key to be engaged by a pivoted bar. This bar is linked to the solenoid plunger. The adjusting screw has a left and right hand thread for adjusting the angle of two toggles fastened to the key bar. These toggles bear against a rocker bar which has a gear segment swedged to one end which engages a gear on the turning condenser gang. Power applied to the solenoid pulls the plunger, tilting pivoted bar. The bar hooks the end of the key and pulls the toggles against

toggle bar. Geared to condenser gang, it aligns with toggle angle and gear segment on bar moves tuning condenser to preset position.

Glass Utilized in Pump

HANDLING commercial quantities of corrosive acids and chemical fluids has long been a difficult problem. Many of these fluids quickly destroy metal pipes and pumps. Also, minute traces of corrosion impurities may completely alter the product.

Glass pipes have been used satisfactorily for such liquids. Now a glass pump of the centrifugal type, has been developed jointly by the Corning Glass Works and Nash Engineering Co. as shown in *Fig.* 2, where the parts are disassembled.

Not only the casing, but also the rotating impeller and all parts in contact with the corrosive fluids are

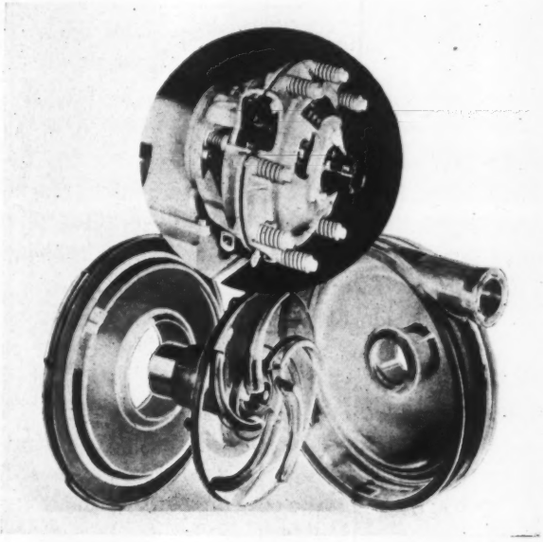


Fig. 2—Principle parts of glass pump showing casing, impeller and back plate. Insert is assembled view for direct connected motor

clear, chemical resisting glass. The rotor is accurately balanced and runs at high speeds without appreciable vibration.

Tire Suggests Clutch Design

UTILIZING inflation of a pneumatic rubber ring similar to an automobile tire the clutch shown in *Fig.* 3 was developed by the General Tire & Rubber Co. Capacity is regulated by internal pressure and can be changed to conform to needs and conditions.

Because of its flexibility, uniform pressure is exerted over the entire surface. For the same reason, the clutch has many of the properties of a coupling when it is engaged and can take care of a reasonable amount of angularity and misalignment. Tests have shown that the low frequency and high magnitude

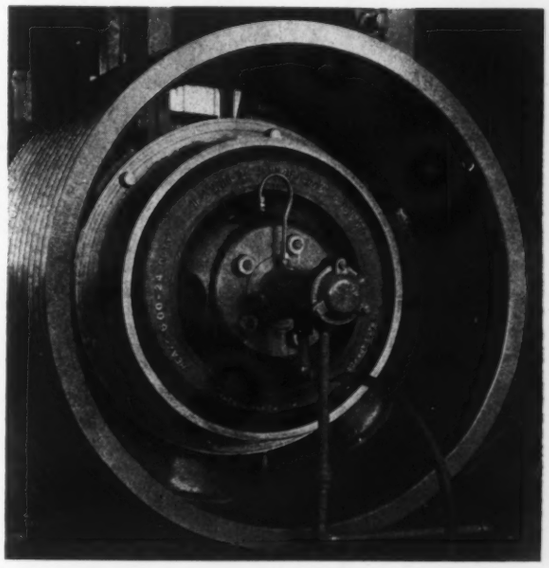


Fig. 3—Clutch utilizes pneumatic ring. Misalignment and angularity are compensated by its flexibility. Uniform pressure is exerted

vibrations of diesels are converted through this clutch to high frequency and low magnitude.

Chrome Plating Improves Performance

CHROME plating insides of tubing bodies has resulted in improved performance of compressed air and water hydraulic equipment of the Tomkins-Johnson Co. After honing, the bodies are plated with approximately .001-inch hard chrome. The result is a smooth, polished surface that will not rust.

Ordinary lubrication methods prevent formation of rust while the cylinders are in use. Cylinders not in use are susceptible to rust if left for any appreciable time, whereas hard chrome plating is lubricated by condensation of compressed air or water which increases the "slickness" of the surface. Also, less friction, prolonged packing life and appreciably increased efficiency are obtained. Outside diameters of piston rods are plated to effect the same smooth lubricated action at the piston rod packing.

Reduces Noise from Stock Support

OBJECTIONABLE noise created by rotation of stock in stock supply tubes has been eliminated through the use of a nonmetallic casing to deaden sound and prevent transfer of vibration. Designed by Brown & Sharpe Mfg. Co., this casing supports a flexible metal guide through which the stock is fed.

Free to slide in an outer support bracket, the casing is secured to an inner support bracket by a simple swing latch to prevent creeping. Stock is inserted by transferring the inner support bracket to a loading position stud, this stud having a vertical adjustment to assure clearing machine.

Factors Affecting Accu

By A. M. Wahl
Westinghouse Electric & Mfg. Co.

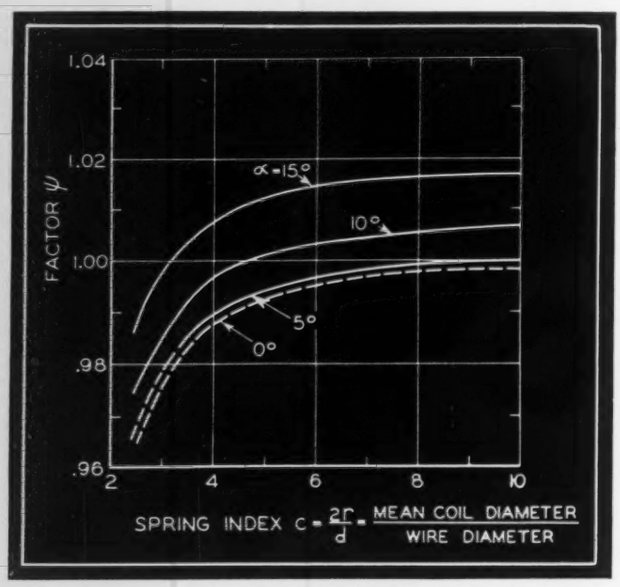


Fig. 1—Factor in spring deflection formula for various values of spring index and pitch angles

MACHINE designers responsible for the application of helical springs frequently find that springs in certain mechanisms do not perform in accordance with design calculations. Actual measured spring deflections may deviate from calculated values by as much as 10 per cent in certain cases. Reasons for this discrepancy will be discussed in this article with particular reference to (1) the accuracy of the formulas used in spring calculations and (2) the modulus of rigidity (or torsional modulus of elasticity) of commonly used spring materials.

Determination of helical spring rates or deflections is of importance in many applications which require a definite spring deflection under a given load. Examples of such applications are scale and instrument springs, springs used in governor mechanisms and centrifugal starting switches in electric motors. In other cases, such as engine valve springs, a proper spring rate is necessary to avoid excessive vibration or fluttering. In general, in most spring applications it is desirable that the actual spring rate be near to the design value.

Because the accuracy of the commonly used helical spring formula has been questioned, the errors involved in using this equation will first be discussed. The formula on which practically all available spring tables are based is

$$\delta_o = \frac{64\,P\,r^3\,n}{G\,d^4} \qquad (1)$$

where the symbols have the following meaning:

δ_o = total deflection of spring at load P
r = mean coil radius = ½ mean coil diameter
d = wire diameter
n = number of active turns
G = torsional modulus of elasticity.

The derivation of this formula is based on the assumption that the spring may be considered as a straight bar under a torsional moment Pr. The angle of twist in such a bar of a length equal to the total active length in the spring when multiplied by the mean coil radius will yield the deflection of the spring. In deriving this formula, however, the following factors are neglected: (1) Curvature of the bar or wire, (2) direct shear due to the axial load and (3) pitch angle of the coil.

The effects have been considered by Goehner[1], who derived a more accurate expression for calculating deflections in helical springs, on the basis of the theory of elasticity, in which the effects of spring index (ratio of mean coil diameter to wire diameter) and of the pitch angle of the helix were taken into account. This more accurate formula may be written:—

$$\delta = \psi\,\delta_o = \psi \times \frac{64\,P\,r^3\,n}{G\,d^4} \qquad (2)$$

where

δ = actual deflection
δ_o = is the deflection figured by the ordinary formula in Equation (1).

$$\psi = \frac{\cos\alpha}{1 + \dfrac{.1875\cos^4\alpha}{c^2-1}} + 2\,\frac{G}{E}\sin\alpha\tan\alpha$$

α = pitch angle
c = spring index = $2\,r/d$
E = modulus of elasticity of the material in tension.

It is seen that the deflection calculated in this manner is equal to the deflection δ_o multiplied by a correction factor ψ which in most practical springs differs very little from unity. In *Fig.* 1, values of the factor ψ

(1) Ingenieur-Archiv., Vol. 1, 1930, p. 619 and Vol. 2, 1931.

...cate Spring Selection

have been plotted against spring index $c = 2r/d$ for various pitch angles α.

In making the calculations the ratio G/E was taken as .38, a ratio which holds for most spring materials. However, relatively large changes in the ratio G/E will have only a negligible effect on the values of ψ. The dashed curve for zero pitch angle cannot be realized in practical springs. A part of the curve for 5 degree pitch angle is shown dashed because it also cannot be realized.

It may be seen that for practical springs where the pitch angle is less than 10 degrees and for the smaller indexes, the value of ψ is less than unity. Therefore the actual deflection is slightly smaller than that calculated from Equation 1. This seems surprising at first because one would expect that the direct shear would act to increase the deflection over that given by the equation. However, tests bear out this conclusion.

It should be noted that in actual springs the effect is usually very small; thus for indexes $c > 2.5$ and pitch angles $\alpha < 15$ degrees, the deviations from the ordinary formula in Equation 1 will be under 2½ per cent. For most springs where $\alpha < 10$ degrees and $c > 4$ the error is under 1 per cent, a figure which is usually negligible, since other factors such as the effects of variations in coil and wire size, shape of end turns, and modulus of rigidity will ordinarily be greater. In certain cases, however, as for example in instrument springs, it may be desirable to use the factor ψ of Equation 2 in making deflection calculations for maximum accuracy.

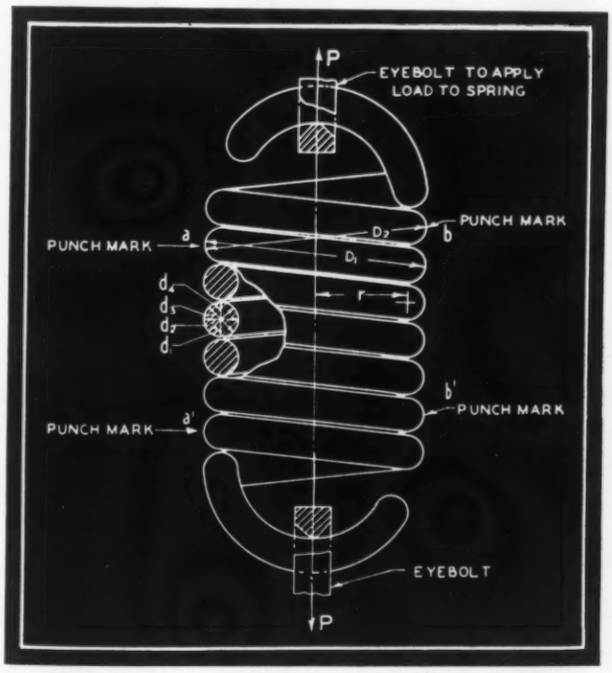


Fig. 2—Method of testing spring for deflection

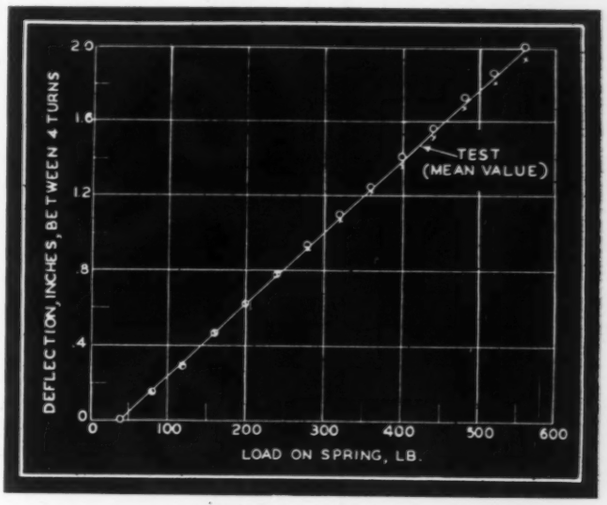


Fig. 3—Deflection test of spring with spring index of 9.5. Points show measurements on opposite sides

Experimental Check of Deflection Formulas

It is interesting to compare the results as figured by means of this more exact formula with the experiments on actual helical springs[2]. Essentially the test method was to wind three tension springs with indexes of 9.5, 4.7 and 2.7 from a single bar of carbon spring steel of ⅝-inch diameter. A total of nine springs cut from three bars of steel were tested. The method of testing is indicated in *Fig.* 2.

Deflections were measured between the punch marks *aa'* and *bb'* in the body of the spring to eliminate the disturbing effects of the end turns. By taking an average on opposite sides, the unavoidable effects of slight eccentricities in loading were eliminated. It was found that the test load-deflection curves were almost exactly straight lines.

A typical test curve for a spring of large index is shown in *Fig.* 3, the mean or average test curve being shown. By tests on the spring of large index made

(2) Trans. A.S.M.E. 1930, p. 217.

from a given bar of material, the modulus of rigidity could be determined from Equation 2 for that particular bar. The results of the determination of modulus of rigidity for the three bars tested were 11.45 x 10^6 and 11.46 x 10^6 and 11.50 x 10^6 pounds per square inch for each bar respectively. This indicates that the modulus varied by less than ½ per cent between the different bars showing the material was uniform.

For springs of small index, the actual deflection was in most cases slightly *less* than that figured by the ordinary formula as shown in *Fig.* 1, that is ψ was less than unity. A typical test curve for a spring of index 2.7 is shown by the full line of *Fig.* 4. The curve

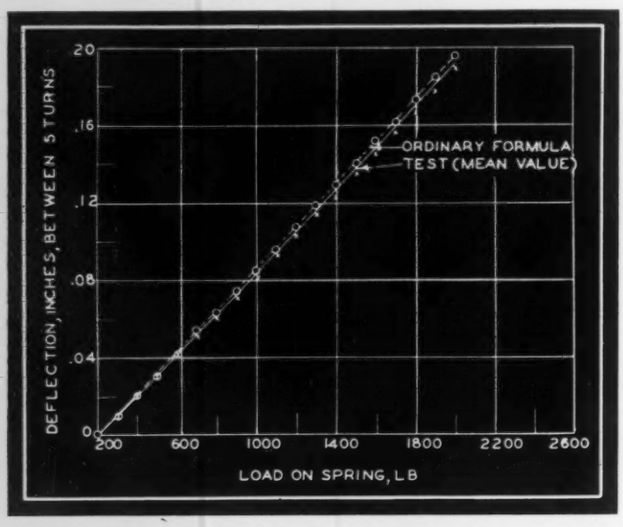


Fig. 4—Deflection test of spring with spring index of 2.7. Ordinary formula values are shown by dotted line

calculated from the ordinary formula of Equation 1 is shown dashed.

A summary of test results obtained on six springs having indexes of 2.7 and 4.7 is given in Table I, which shows the percentage deviation between the test curves and the curves calculated from the ordinary formula. A negative deviation shows that the deflection was slightly less than that calculated by means of the ordinary formula. The average test values are within about .7 per cent of the corresponding calculated values using the more accurate method. This indicates that more accurate values of spring deflections may be obtained by multiplying the deflections figured by the ordinary formula by the factor ψ of *Fig.* 1.

Effect of Pitch Angle on Deflection

The curves of *Fig.* 1 indicate that the effect of pitch angle on the spring deflection is very small. For all spring indexes over 2½, a change in pitch angle from 5 degrees to 15 degrees (which is an extremely large change) means an increase in ψ of about 2 per cent with a corresponding increase in deflection of 2 percent. These curves also indicate that the effect of changes in pitch angle is about the same regardless of spring index. In general, the effect of pitch angle may be neglected except where extremely high accuracy is desired.

Torsional Modulus of Spring Materials

As may be seen from Equation 1, in calculating helical spring rates or deflections, it is necessary to know the torsional modulus, or modulus of rigidity G, since the accuracy of the calculation depends on how accurately G is known. Unfortunately there is considerable variance in the reported experimental values of G. The best that may be done is to choose an average figure with the reservation that actual deviations may in certain cases reach several per cent.

The modulus of rigidity is reduced to some extent by overstraining the material. However, there is a tendency for a part of this reduction to be regained after the material has stood for some time. Adams[3] found that by overstraining in torsion straight bars of high carbon spring steel a reduction of several per cent in the modulus of rigidity was obtained (although this decrease could be eliminated by a proper low temperature heat treatment after the overstraining).

Similar results were obtained by Pletta, Smith, and Harrison[4], on actual springs of about ¾-inch-diameter wire. These investigators found decreases in the torsional modulus varying from about 1 to 5 per cent depending on the amount of overstraining, and a tendency of the modulus partially to recover its initial value after a considerable lapse of time.

Another factor which has an effect on the modulus of rigidity is the degree of decarburization of the wire surface in the completed spring. It is clear that if there is a decarburized layer of material on the surface, when the spring is stressed this material will act like low carbon steel and will yield at a low load.

At higher loads the spring will act to some extent as if the layer of decarburized material is not present. In other words the load-deflection rate will be roughly

TABLE I

Measured and Calculated Deviations from Ordinary Helical Spring Formula

Spring Index $2r/d$	Bar No.	Deviation in Per Cent—Test	Deviation in Per Cent—Average	Deviation in Per Cent—Calculated*
2.7	1	—3	—1.7	—2.4
2.7	2	0		
2.7	3	—2.2		
4.7	1	—1.3	—1.0	— .7
4.7	2	—1.6		
4.7	3	0		

*Using factor ψ, effect of pitch angle considered.

that corresponding to a bar or wire having a diameter equal to the actual diameter minus twice the thickness of the decarburized layer. Since the actual diameter is used in the spring formula, this effect is the same as if the effective modulus of rigidity were decreased.

For example take a spring made of ½-inch hot

(3) Carnegie Scholarship Memoirs, Iron & Steel Inst., 1937.
(4) Virginia Polytechnic Inst. Eng. Exp. Station Bulletin No. 24.

wound stock and assume that the decarburized layer extends .01 inch into the material. At the higher loads, since the decarburized layer contributes but little to the strength, we may assume a load-deflection rate corresponding to a bar diameter of .50 — 2(.01) = .48 or 4 per cent under size. Since the load-deflection rate varies as the forth power of the wire size this means a reduction of about 17 per cent in the former, or a decrease in effective modulus of rigidity of 17 per cent. In many cases, spring manufacturers assume a modulus figure about 10 per cent less for hot rolled carbon spring steel than for hard drawn material. The above example shows that a decarburized layer around 6 mils thick in ½-inch diameter stock would be sufficient to account for this lower modulus value. Such a layer may easily occur in hot wound spring materials.

A summary of available test data on modulus of rigidity of carbon spring steels is given in Table II.

TABLE II

Modulus of Rigidity for Carbon Spring Steels

Material	Heat Treatment*	Wire or Bar Diameter Inches	Modulus of Rigidity lbs. / in.²	Investigator
1% C. Steel	Q & T	¾	11.6×10^6	Edgerton[1]
1% C. Steel	Q & T	½	11.82×10^6	Adams[2]
1% C. Steel	Q & T†	½	11.14×10^6	Adams[3]
1% C. Steel	Q & T	9/16	11.2×10^6	Wahl[4]
1% C. Steel	Q & T	⅝	11.47×10^6	Wahl[5]
.67% C. Steel	Oil Temp.	.028 to .08	11.12×10^6	Sayre[6]
Music Wire		.035	11.4×10^6	Brombacher & Melton[7]
Hard Drawn Wire			11.4×10^6	Sayre[6]

Q & T = Quenched and temepred. †Overstrained 50%, mild heat treatment.

(1) These values of G are averages calculated from spring deflection tests reported by Edgerton, Trans. A.S.M.E., Oct. 1937, p. 609. Deflection method used for tests.

(2) Carnegie Scholarship Memoirs, Jl. Iron & Steel Inst., 1937, pp. 1-55. Direct method used for test.

(3) This value of G obtained by overstraining at a torque about 50% above that corresponding to the proportional limit. Direct method used for test.

(4) Unpublished test data. Deflection method used for test.

(5) Trans. A.S.M.E. 1930, p. 217. Deflection method used for test.

(6) Trans. A.S.M.E. 1934, p. 556. Torsional pendulum tests.

(7) N.A.C.A. Report No. 358, 1930, p. 568. Torsional pendulum tests.

Individual data were obtained by various investigators using (a) the deflection method, involving deflection measurements on actual springs, (b) direct method, where the twist of a bar of spring material in torsion is measured, or (c) torsion pendulum method, involving measurements of the period of a torsion pendulum using the spring wire as the flexible element. In each case the method used is indicated in the footnotes associated with the investigators.

The two tests by Adams on ½-inch bars of carbon spring steel were conducted on the same material. The second test was performed after overstraining at a torque 50 per cent above the torque corresponding to the proportional limit, followed by a mild heat treatment at 228 degrees Centigrade. The reduction in modulus of rigidity from 11.82 to 11.14 $\times$ 10^6 pounds per square inch gives an idea of the reduction which results from stressing helical springs far beyond the proportional limit of the material. This investigator showed that by increasing the temperature of the mild heat treatment from 228 to 275 degrees Centigrade this reduction in the modulus figure due to overstraining was practically eliminated.

A comparison of the various modulus figures indicates that a variation in the torsional modulus of carbon spring steels from say 11.1 $\times$ 10^6 to 11.8 $\times$ 10^6 for various conditions may be expected, the value of 11.5 $\times$ 10^6 pounds per square inch being an average.

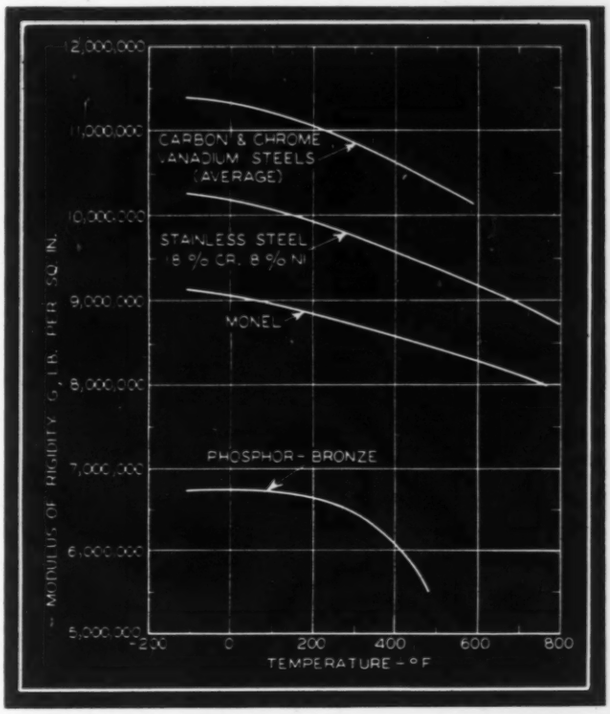


Fig. 5—Effect of temperature on modulus of rigidity

It should also be noted that variations of ± 5 per cent from this figure may be obtained in some cases, while as mentioned before if the spring wire has a decarburized layer of appreciable thickness even larger variations are possible. The higher value of 11.82 $\times$ 10^6 obtained by Adams was probably due to the fact that no decarburized layer was present and that the material was not overstrained. The lower values of G found for the other cases are probably largely due to either or both of these effects. These latter figures are, however, more representative of those to be expected in actual springs.

A summary of available test data on the modulus of rigidity of spring materials other than carbon steels is given in Table III. On the basis of this data rough average values of the modulus of rigidity may be taken as: 11.5 $\times$ 10^6 for chrome vanadium steels, 10.6 $\times$ 10^6 for stainless steel (18 per cent Cr, 8 per cent Ni), 9 $\times$ 10^6 for Monel metal, 6.4 $\times$ 10^6 for phosphor bronze. In this table, the method of determination is shown in the footnotes as in Table II.

In general the modulus of rigidity of spring materials drops off with increase in temperature. However, sufficient test data are not available to enable an accurate determination of this effect as a function of temperature.

TABLE III

Modulus of Rigidity of Alloy Spring Steels, Stainless Steel, Monel Metal and Phosphor Bronze

Material	Heat Treatment*	Wire or Bar Diameter Inches	Modulus of Rigidity G lbs. / in.²	Investigator
Cr-Va Steel 1.38 Cr .17 Va .21 Ni	Q & T	½	11.75×10^6	Adams[1]
Cr-Va Steel 1.06 Cr .17 Va	Q & T	.148	11.2×10^6	Zimmerli, Wood, Wilson[2]
Cr-Va	Q & T	.375	11.45×10^6	Berry[3]
Stainless Steel 18 Cr 8 Ni	A & C. D.	.148	10.5×10^6	Zimmerli, Wood, Wilson[2]
Stainless Steel 18 Cr 8 Ni	C. D.	.04 to .162	10.8×10^6	Wahl[4]
Monel Metal	A & C. D.	.125	9.1×10^6	Zimmerli, Wood, Wilson[2]
Phosphor Bronze	A & C. D.	.09	6.7×10^6	Zimmerli, Wood, Wilson[2]
Phosphor Bronze			6.3×10^6	Sayre[5]
Phosphor Bronze		.081	6.2×10^6	Brombacher & Melton[6]

*Q & T = Quenched and tempered; A & C. D. = Annealed and cold drawn.

(1) Carnegie Schol. Memoirs, Iron & Steel Inst. 1937, pp. 1-55. Direct method used for test.

(2) Proc. A.S.T.M. 1930, Part II, p. 357. Direct method used for test.

(3) Proc. Inst. Mech. Engrs. 1938, p. 460. Direct method used for test.

(4) Unpublished test data. Deflection method used for test.

(5) Trans. A.S.M.E. 1934 p. 556. Torsional pendulum tests.

(6) N.A.C.A. Tech. Rep. No. 358, 1930, p. 568. Direct method used for test.

A rather complete investigation of the drop in the modulus of rigidity from —50 degrees Centigrade to +50 degrees Centigrade for various spring materials has been carried out by Keulegan and Houseman[5]. They found that within this range for most materials the modulus of rigidity could be represented approximately by

$$G = G_o (1 - mt) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where

G = modulus of rigidity at 0°C.
m = temperature coefficient of modulus
t = temperature, degrees Centigrade.

Average values of m obtained by these investigators for various spring materials are shown in Table IV.

For example, an increase in temperature from 0 to 50 degrees Centigrade for music wire would mean a drop in the modulus of $m \times 50G = .00026 \times 50G = .013G$ or 1.3 per cent in this range. Where extreme accuracy is desired this may be important.

An idea of how the modulus of rigidity drops with temperature varying from —100 degrees Fahr. to 600 or 800 degrees Fahr. may be obtained from the curves of *Fig.* 5. These were obtained by drawing smooth curves through test data published by Zimmerli and his collaborators[6]. Since the actual test data reported showed considerable irregularities, these curves should be considered as giving only a rough indication of the trend of modulus change with temperature.

An accurate determination of deflection in helical compression springs requires that the effect of end turns be estimated with reasonable accuracy. For compression springs with squared and ground ends, as ordinarily formed, it is satisfactory in most cases to take the number of active coils as equal to the total number minus two. This is for the usual design of compression spring where the number of free coils at zero load is approximately equal to two less than the total number. Deflections in individual springs may vary from these characteristics depending on the actual shape of the end turns.

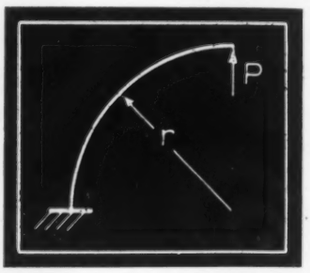


Fig. 6—Loading of end loop of tension spring

In the case of tension springs, measurements made by Sayre[7] indicate that a half coil turned up to form a loop is equivalent to .1 turn as far as deflection is concerned, while a full coil turned up part way to form a loop, the load being applied along the spring axis, is equivalent to .5 turn. In the first case where a half coil is turned up to form a loop, the loading conditions are equivalent to the quarter-bend of *Fig.* 6, the solution of which may be obtained from curved bar theory[8]. The solution is

$$\delta_1 = \frac{\pi}{4} \frac{P r^3}{E I} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

E = modulus of elasticity of material in tension
I = moment of inertia of wire section
P = load on loop
r = radius of loop
δ_1 = deflection due to loop.

Since for most spring materials $E = 2.6G$ where

(*Concluded on Page* 86)

TABLE IV

Temperature Coefficients of Modulus of Rigidity from −50° C. to 50° C.

Material	Coefficient m
Oil Tempered Steel (.66%C)	.00025
Music Wire	.00026
Chrome-Vanadium Steel (.98% Cr. .24% Va) Quenched and tempered	.00026
Stainless Steel (18% Cr 8% Ni) Hard Drawn	.00040
Monel Metal Hard Drawn	.00032
Phosphor Bronze Hard Drawn	.00040

(5) Bureau of Stds. J1, of Res., Vol. 10, 1933, p. 305. See also Brombacher & Melton, N.A.C.A. Tech. Report No. 358, 1930.

(6) Proc. A.S.T.M. 1930, Part II, p. 356.

(7) Trans. A.S.M.E. 1934, p. 558.

(8) See for example Timoshenko, Strength of Materials, Part II, 1930, p. 435 (Van Nostrand), or the writer's paper in Trans. A.S.M.E. 1928, p. 241.

Why Streamline?

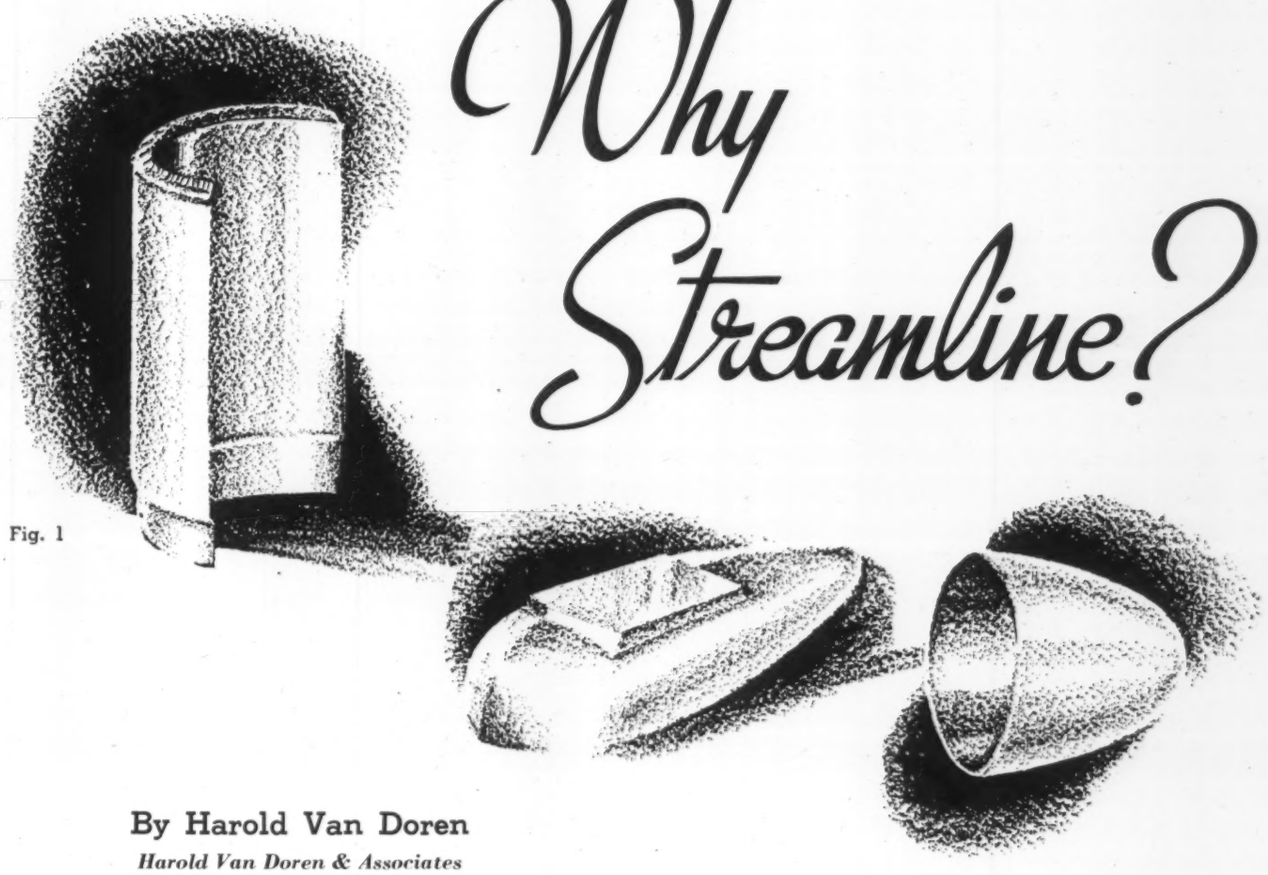


Fig. 1

By Harold Van Doren
Harold Van Doren & Associates

SO-CALLED "Streamlining" is a phenomenon no designer can afford to ignore. Although its original meaning has been obscured and is not met as frequently in problems of industrial design as the public probably thinks, this trend of employing flowing curves and enclosures to give smooth and clean appearance to a machine is definitely desirable.

Manufacturers who want washing machines, typewriters, or turret lathes "streamlined" in reality desire to modernize them, to find a means for substituting curvilinear forms for rectilinear ones. They want cast iron, die-cast zinc, plastics and sheet metal to conform to current taste, for cylinders and spheres or soft flowing curves replacing harsh angles and ungainly shapes of a decade ago.

They expect, too, the elimination of unnecessary exposure of mechanical parts, the substitution of buttons for levers and arrangements of control panels and dials into simple and easily read groups, all tied in wherever possible with related elements.

This procedure is usually unrelated to genuine streamlining which involves shapes calculated to meet a minimum resistance to motion. Then why is it referred to as such? And why should designers be streamlining everything from wrist watches to locomotives, from candy dispensers to stamping presses?

Simply because, in the unbelievably rapid growth

**The author's forthcoming book,* Industrial Design—A Practical Guide, *to be published by the McGraw-Hill Book Co., will contain a chapter based upon material similar to that contained in this article.*

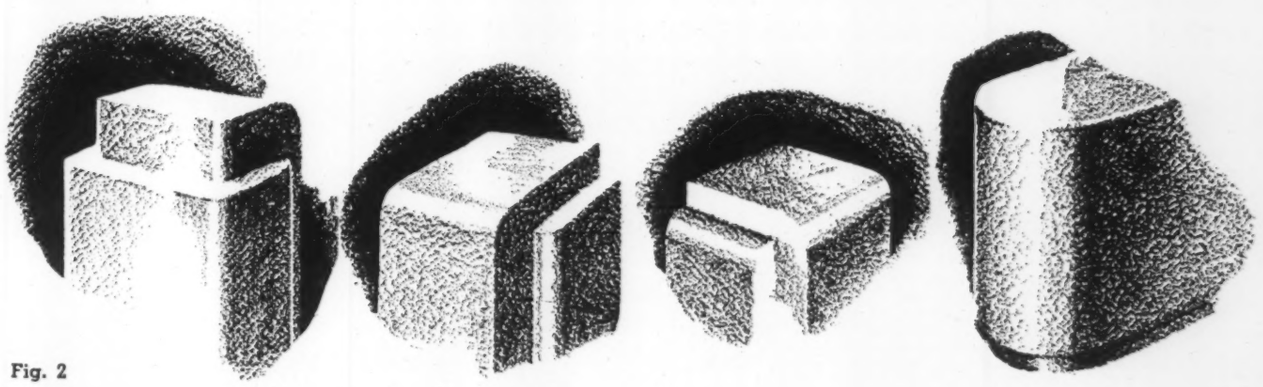


Fig. 2

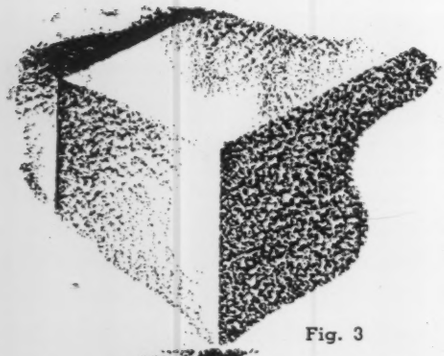


Fig. 3

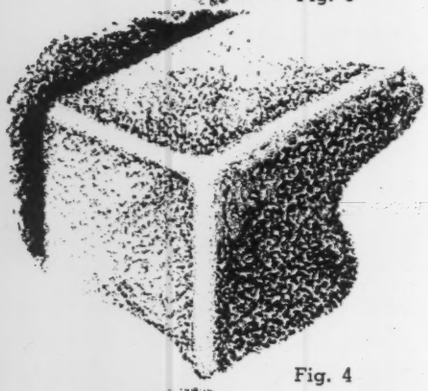


Fig. 4

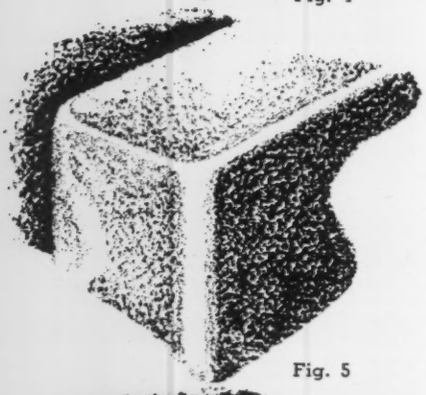


Fig. 5

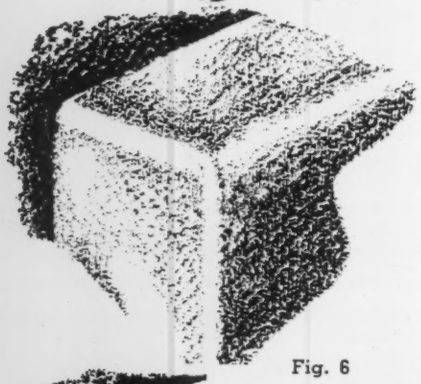


Fig. 6

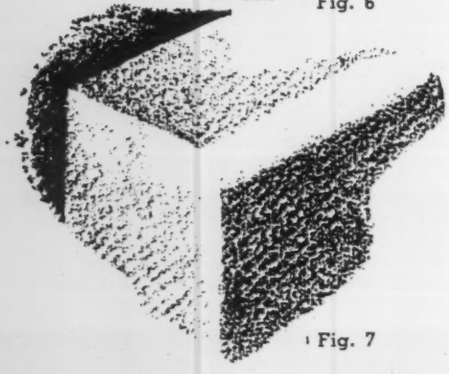


Fig. 7

of the American language, words soon lose their specific and restricted meanings and assume a general significance embracing far wider fields than originally intended. The streamlined washing machine today means a modern washing machine. It means the latest, up-to-the-minute machine that can be bought, something so advanced that it is almost more of the future than of the present.

Since streamlining has come to mean the substitution of radii and fillets for sharp angles and corners and is an important factor in modern design, it will be necessary to discuss ways and means of accomplishing these effects. But first some of the manufacturing processes involved will be treated.

Fabrication in the sense the word is used in the manipulation of sheet metal permits forming metal in limited ways on shears, quick-work machines, brakes, rolls, and radius formers. After component parts are thus formed, they are fastened together by various means: Rivets, bolts, self-tapping screws, and welding.

Stamping or drawing metal is fundamentally a different process. It may involve one or many different operations to develop a given shape. But it permits the designer greater latitude in the development of what, for want of a better name, is called "freehand forms," that is, forms curved in two or more planes at the same time. Fabrication methods cannot produce true streamlined shapes, stamping techniques can.

Spinning, a semimanual process not common in high-production manufacture, can form sheet metal with a freehand curve in one plane and true circles in a plane at 90 degrees to it. These three processes may, of course, be combined in various ways. A stamped form may be finished by spinning, and fabricated parts are sometimes given finishing touches on stamping presses.

Various methods of casting and forming metals, plastics, and rubber—in fact any of the methods whereby the material takes its shape after being introduced in a molten form, or a form which becomes molten or plastic under heat or pressure or both—are also capable of producing true streamlined shapes.

Three typical shapes shown in *Fig.* 1 illustrate some of the processes mentioned. The one at the left has been fabricated. The main part was shaped in rolls. The bead near the top was put in on a small rolling machine equipped with cylindrical dies. The "revealed" edge at the bottom was accomplished in the same manner, being offset just the thickness of the metal so that a base could be fastened to produce a flush joint.

Examples of Stamped and Cast Shapes

This form could also have been made on a stamping press. If it were, the piece price would probably be less, but the die cost would be large. The process used would thus depend entirely on the number of units manufactured. The body is a half-cylinder, curved in one plane only, which distinguishes it from a typical stamped form.

Now examine the center illustration. It is an imitation of a streamlined shape, borrowed from aeronautical practice and could be the base of an electric fan or a domestic food mixer. This form could not possibly be made by fabrication methods. If made of sheet metal it would have to be stamped. It could also be produced by casting or molding. The next sketch, at the right shows another genuine streamlined form, the tapered shell of a hair-drying machine.

It could be made by spinning, stamping, casting, or molding, but would be impossible to fabricate because again it is curved in more than one plane.

Fabricating sheet metal, for all its limitations, offers possibilities which have not been fully exploited. In *Fig.* 2 are indicated basic shapes which can be made by fabrication methods. They are not intended to represent any particular equipment, being presented as abstract forms only. With ingenuity and proper equipment, any one of them can be fabricated. Certain subtleties, such as the "peaked" treatment mentioned in the article, *Illusions Aid Appearance** might also be introduced, but it would be well to use this treatment sparingly, and only on plane surfaces. You cannot push this peak around a curve without changing the technique to stamping.

Now let us look at a few simple corner treatments for light sheet-metal casings, square in shape. Low cost is paramount; volume does not warrant the use of expensive stamping dies. Yet "streamlining" is desirable. Perhaps the treatment permitted is merely on the corners and edges, plus a little striping, a few lines of chrome beading, color selection, and a nameplate.

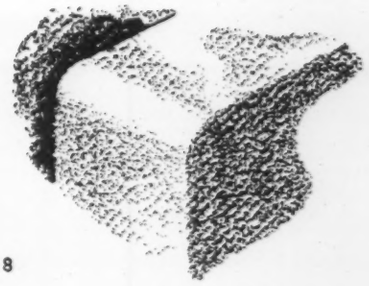


Fig. 8

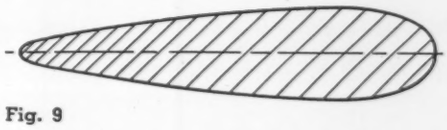


Fig. 9

Possibilities in an Intersection of Three Flat Planes

There are good and bad ways of rounding edges and of treating corners where three planes meet. In *Fig.* 3, the corner of a small domestic air-conditioner is treated as it normally would have been done if "streamlining" had not become popular. There is nothing wrong aesthetically with a corner like this as a form but in fabricated metal it has a tendency to make the entire casing look cheap. Let us see what can be evolved out of this uncompromising form.

Fig. 10

A first thought would be to put a radius on all three edges, where the planes intersect. This produces a "ball corner" as shown in *Fig.* 4. There are several ways of making it, such as notching out the corners and inserting a piece made on small corner dies, then spot-welding it into position, or, welding on a corner piece and grinding off the excess metal. Again as design it is all right, but not particularly interesting. The trouble is that all of the radii are the same.

Fig. 11

We can enlarge the radius of the vertical edge as in *Fig.* 5. This will help give character and variety. It creates, however, a somewhat peculiar shape for the corner piece. If the entire top could be a shallow stamping, everything would be well, for a flush joint could be obtained by offsetting the metal on the side-and-front piece with a small roll.

Fig. 12

Enlarging the radius on the horizontal edges is another alternative as in *Fig.* 6 but it involves difficulties. The juncture of a small radius on the vertical edge with two larger ones on the horizontal plane produces a peak and results in a free-hand three-dimensional form not particularly pleasant to the eye, and difficult to make.

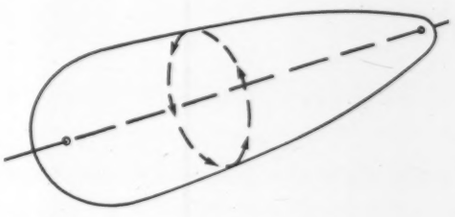


Fig. 13

Perhaps we should throw caution to the winds and try something more radical. The limitations of fabrication are such that we cannot dome the top and indulge in any freehand forms. But two things can be done. The radius of the front edge can be increased, producing a soft roll from front to back; or, the radius at each side can be enlarged, again producing a markedly different effect as in *Figs.* 7 and 8. Both of these latter would require the use of a radius former, unless stamping were employed. Which method is chosen depends on the other minor forms involved, the mechanisms inside, and the location of the product in its final installation.

The chief purpose of this demonstration is to indicate the *form* possibilities inherent in a simple intersection of three flat planes, manufactured by one of the most limiting of all production methods. Much more intricate designs could be developed by combining fabri-

Fig. 14

*MACHINE DESIGN, *April*, 1939.

cation with stamping technique, or by using die-cast or sand-cast parts to obtain the desired forms.

The exact amount of radius which will look best in various combinations can only be determined by modeling them full size in relation to the completed product. Clay modeling or full size wooden dummies should be built before making final decisions, because the

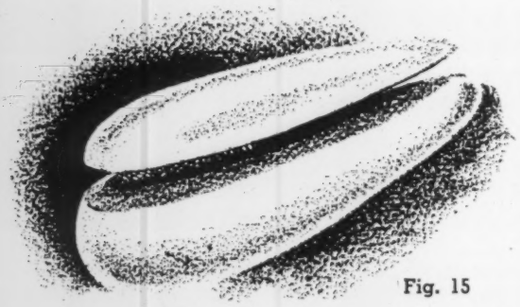


Fig. 15

exact amount of curvature of these radii may mean the difference between something distinctive and something commonplace. If different radii are used, they should be definitely different, not almost alike.

Streamlined forms cannot be decided on paper. Modeling to scale or full size is essential. Sketching with pencil is useful, but it can never give a true picture of freehand forms.

The real field of true streamlining is transportation, especially the airplane. It has many hydraulic applications as well. In both of these fields it is functional.

Streamlining in automobiles, incompletely realized

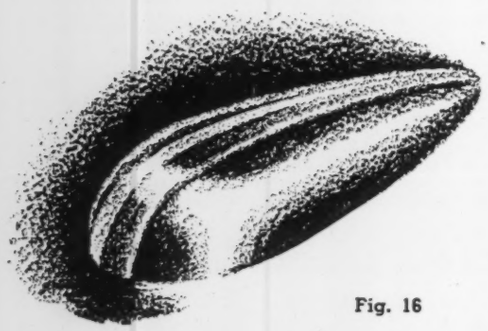


Fig. 16

as it is, increases speeds and cuts fuel consumption. Since the power required to overcome air resistances increases as the cube of the speed, really scientific streamlining could increase average speed 60 per cent and reduce gasoline consumption about 40 per cent.

The real popularizer of the streamline idea was a genius of the theater, Norman Bel Geddes, who put his talent and enthusiasm into the visualization of a world of the future, in which everything that moved through water or air or under the sea was somehow manipulated into the shape of a catfish, blunt before, slender and pointed behind.

The basic shape from which all "streamline" forms derive is the air-foil section familiar to the aeronautical engineer. It has many variations, long and thin, or blunt and ovoid, like a drop of water falling through the air. By variation of pitch and curvature it may be made to have greater or less lifting power when applied to the wing of a plane; the blunt nose parts the air and the trailing tail allows the slip-stream to close behind with the minimum of turbulence and resultant drag. *Fig.* 9 shows one of many possible sections, in this case symmetrical around the long axis.

If we go back to the dots in a former article, *Design for Appearance** we might find an aesthetic reason for this shape based on rhythm and movement. Suppose some dots are arranged in a straight line as in *Fig.* 10 with spacing diminished in geometrical progression. Even though the dots are small and all the same size, an impression of forward motion is obtained. Now, if the size of each dot increases progressively, as in *Fig.* 11 the suggestion of forward motion, of speed, is heightened. An enclosing line as in *Fig.* 12 suggests the airfoil section.

Spun around on its long axis, an airfoil section pro-

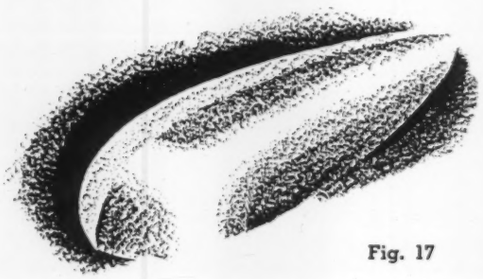


Fig. 17

duces the solid shown in *Figs.* 13 and 14. If this solid is sliced at any point parallel to the long axis, streamlined shapes varying in outline but analogous to the parent form are obtained. *Fig.* 15 for instance shows such a form which is similar to the base in *Fig.* 1.

Variations of many kinds might be developed from this shape. A band could be superimposed over it, as in *Fig.* 16. Interesting variety would be obtained by bringing it to a slight peak in the center like *Fig.* 17.

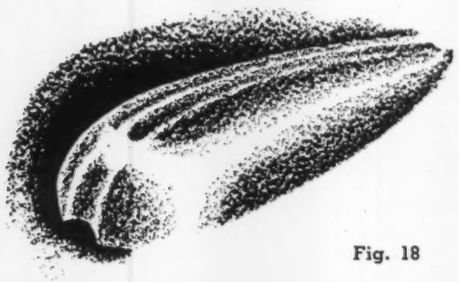


Fig. 18

Ribs or flutes might be added, as in *Fig.* 18.

Thus many forms may be developed in the abstract. As the designer proceeds fascinating shapes will develop, each leading to others and suggesting various machine design applications.

*MACHINE DESIGN, *February,* 1935.

Flexible Shafting Facilitates Control Problems

By John W. Greve

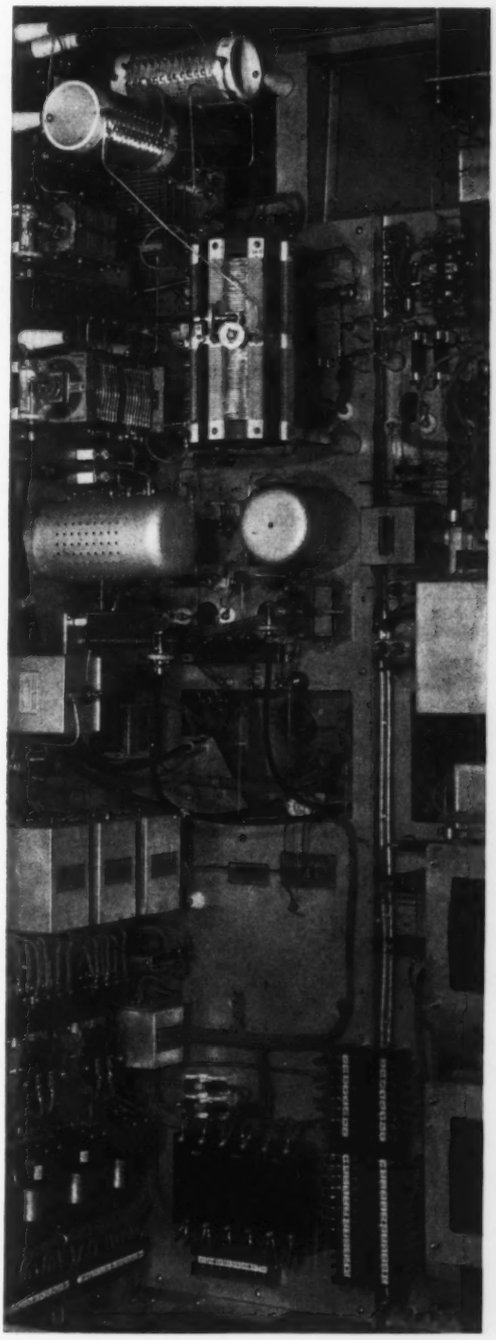


Fig. 1—Flexible shafting permits placement of parts without regard to location of controls

USUALLY the point of control best suited for a particular application is neither adjacent nor in line with the functions controlled. Use of flexible shafting obviates mechanical linkages or methods involving detailed design for each motion. When the relatively simple requirements for application are provided, no alignment except at fittings is required and the shafting may be turned through any number of bends. For example, with small shafting, radii of 1½ inches are satisfactorily employed.

In addition, this type of control is particularly suitable for initiating or controlling a motion on an adjustable part of a machine whereas mechanical linkage would be complicated or require readjustment each time a position is changed. Often, if the part is reciprocating, the initiating control is mounted stationary either to reduce the inertia of the moving part or to protect delicate mechanisms from vibration.

The radio transmitter in *Fig.* 1 shows the use of six flexible shafting units to permit location of controlled elements, without regard to front panel appearance, at the place where consideration of electrical performance dictates. Knobs may be placed

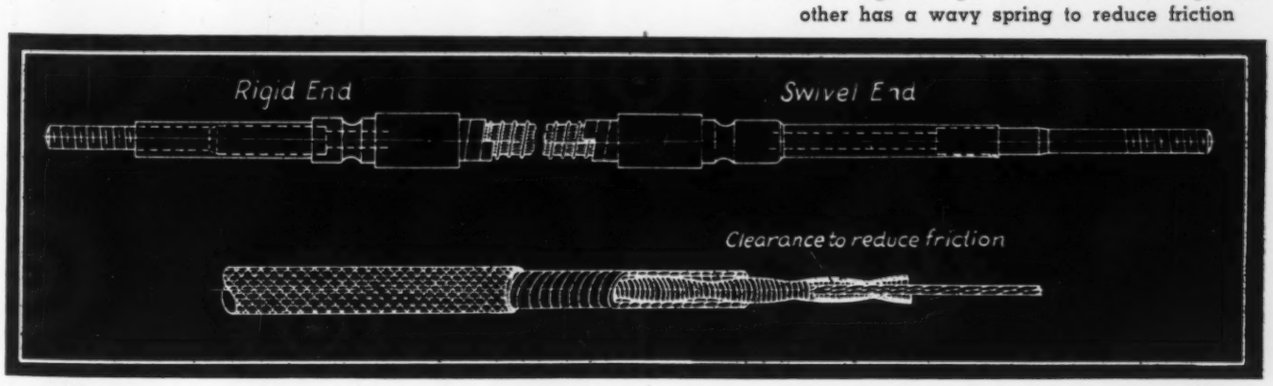


Fig. 2.—Two types of shafting. One is a unit with fittings for rigid and swivel mounting. The other has a wavy spring to reduce friction

where convenient. In this type of transmitter, flexible shafting as long as six feet is used with negligible backlash. In larger equipment, units 15 to 20 feet long have been used although of a larger size.

To reduce the torque transmitted a 6:1 reduction gear is on the driven element. Choice of the proper ratio depends of course upon the torque exerted and the backlash permissible. All these controls have 180 degrees rotation with stops to limit travel to this range. No indicating dials are used on the controls because correct adjustment of each element is indicated by an ammeter or voltmeter in the associated electrical circuits.

Earth inductor compasses as illustrated in *Fig.* 4, designed for aircraft and small boats, require having the compass remote from metal masses and electrical disturbances. Because the course setter and course indicator are located in the cabin, flexible shafting up to 25 feet long is used without noticeable backlash between compass and setter. A hole in the crank with

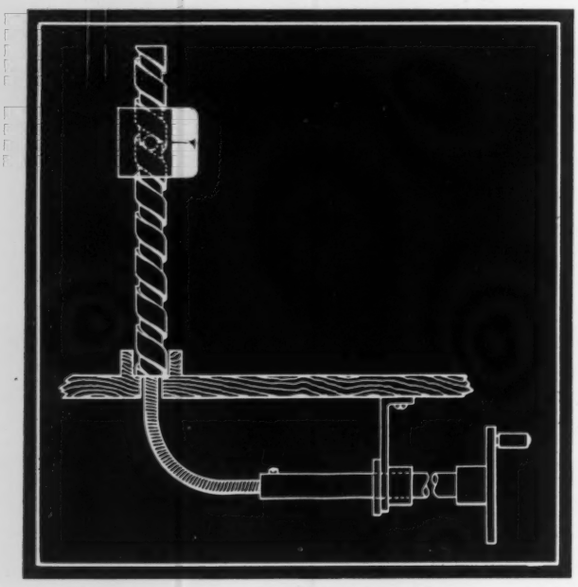


Fig. 3—Rotating and linear motion obtained at right angles with flexible shaft

setscrew fastens the shaft at one end. At the other a worm gear is fastened similarly to rotate the compass.

Flexible shafting comprises two principal parts—outer casing and inner sliding or rotating member. Casings are usually flat or round steel wire wound in one or more layers to provide flexibility. Fabric casings or covers are also used as well as brass tubing. The latter is for applications requiring rigid conduit. Some inner members are closely wound wire either steel or phosphor bronze, inside of which is a flexible aircraft cable. Others are wound strands or solid wire such as piano wire.

In *Fig.* 2 two types of shafting are illustrated. The upper one has end fittings attached. One end is for rigid mounting and the other swivels to compensate for rise and fall of lever eye through arc of travel.

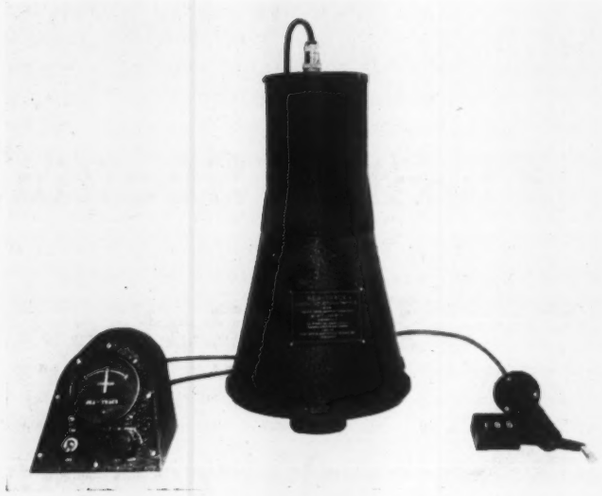


Fig. 4—This compass is accurately controlled without backlash at distances of 25 feet

The lower one employs a casing of wavy shape to reduce friction and provide clearance for lubricant. The clearance also allows foreign particles to lodge without friction or binding action.

Shafting end may be swaged, tinned or sometimes brazed for assembly into fittings. Many types of end fittings are employed such as gear, worm or key fastened by set screws, collet or swaged on the shaft. The outer casing is secured against motion by a clip or clamping unit.

Any number of bends may be employed in the system but the use of too small a radius should be guarded against to prevent excessive friction. Another precaution required is to fasten the casing securely with proper fittings in such a way that the motion of the shaft is not restricted by binding. Also when operated by a lever it is necessary to provide sufficient distance from fastening to allow motion through the arc of lever travel.

When properly applied, lost motion in flexible shafting is negligible. For longitudinal motion, it is a function of the number of 90-degree radii or equal to the number of such bends multiplied by the clearance between movable shaft and sheath, whereas in rotating units it is proportional to the torque required. For practical purposes, the number of bends has no effect upon torsional deflection.

In the table are shown typical characteristics for

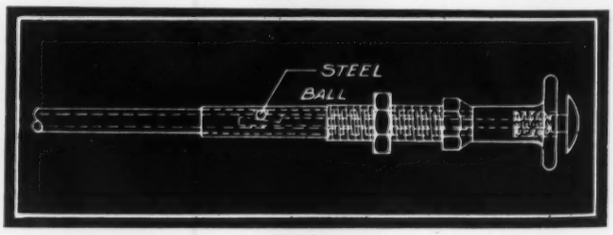


Fig. 5—Steel ball locks position. Central knob releases lock for push-pull operation

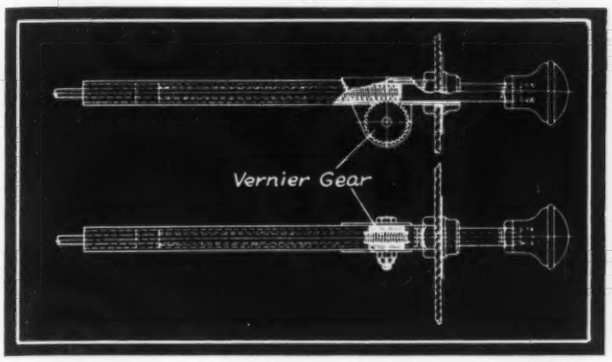


Fig. 6—Both coarse and fine adjustment are obtained with same knob by use of vernier gear

shafting applications involving rotation. Minimum radii of curvature, torsional strength and torsional deflection are given for different diameters of shaft. Torsional deflection is shown as the number of degrees twist for each pound-inch of torque per foot of shaft length. Where this deflection would be excessive, a

Shaft Characteristics

Shaft Diameter	Min. Operating Radius	Torsional Strength	Torsional Deflection
In.	In.	Lb.-In.	deg./lb.-in./ft.
.130	3.25	11	10
.150	3.5	17	7
.188	4	25	3
.212	3.25	25	2.5
.240	4	45	2.5
.312	4.25	90	1
.437	6	275	.3

worm and gear reduction is used to decrease the torque on the shaft and provide the degree of control required. Selection of reduction is merely a balance between allowable deflection by gear ratio and amount of rotation necessary.

Combination of rotation and linear movement is illustrated in *Fig.* 3 wherein a pointer is required to travel along an indicating scale according to the revolutions of the crank. Flexible shafting is used for a

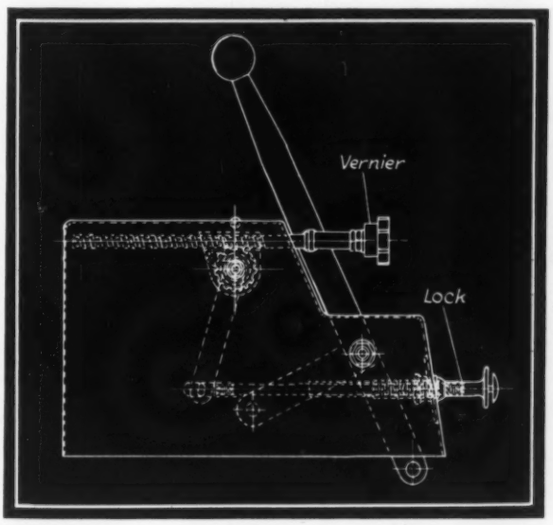


Fig. 7—Lever control with lock and vernier knob for fine adjustment of movement

90-degree turn. A helical screw is chosen with a lead to move the pointer from end to end at the limits of rotational travel.

For manual control operations several types of units may be employed. For example, *Fig.* 5 shows a push-pull unit with a self-locking arrangement. For movement, the central button is depressed which frees a steel locking ball. Release of this button locks the unit in any position by wedging the ball between the stationary sleeve and a cam associated with the button. This locking action is varied by increasing or decreasing the spring tension.

A vernier unit whereby coarse adjustment is obtained by pushing or pulling the knob and a fine adjustment by rotating knob, is shown in *Fig.* 6. The plunger is threaded so that horizontal motion turns a meshed gear. However, when the knob is turned, friction washers on each side of gear resist its rotation and provide a vernier adjustment of the plunger.

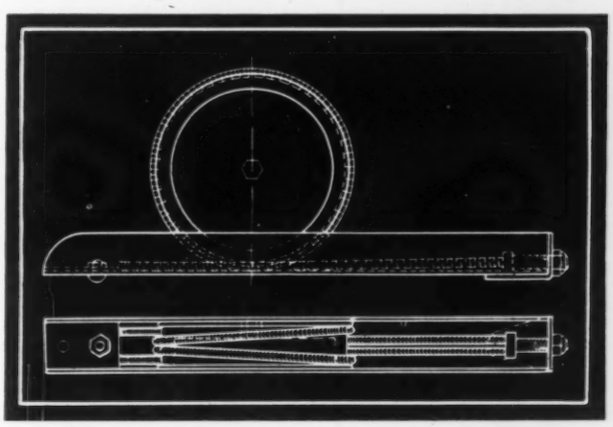


Fig. 8.—Combination push-pull-rotate unit. Degree of rotation is determined by pulley size and length of slide

Another unit using levers such as for throttle controls in aircraft, employs a similar type of vernier adjustment and is shown in *Fig.* 7. The lever is used for coarse adjustment and for vernier adjustment, the lower knob is pulled out locking the vernier gear by a fast lead axial thread. Fine adjustment is then obtained by turning the knob.

Often a push-pull unit is required to translate linear into rotary motion or rotary into linear motion. Ordinarily a rack and pinion is employed. An alternative unit in *Fig.* 8 is an effective and simple way of obtaining the same result. Coiled music wire under initial tension is wrapped around the pulley with each end fastened at opposite ends of the rack as shown. This arrangement may be used in conjunction with all of the units discussed including the locking and vernier types. Variable or cam motion is obtained by designing the pulley with a roll curve as required.

Co-operation of the following companies in the preparation of this article is gladly acknowledged: Air Track Manufacturing Corp., American Chain & Cable Co., Arens Controls, RCA Manufacturing Co., and S. S. White Dental Manufacturing Co.

Load Characteristics of Ru

By J. F. Downie Smith
Edward G. Budd Mfg. Co.

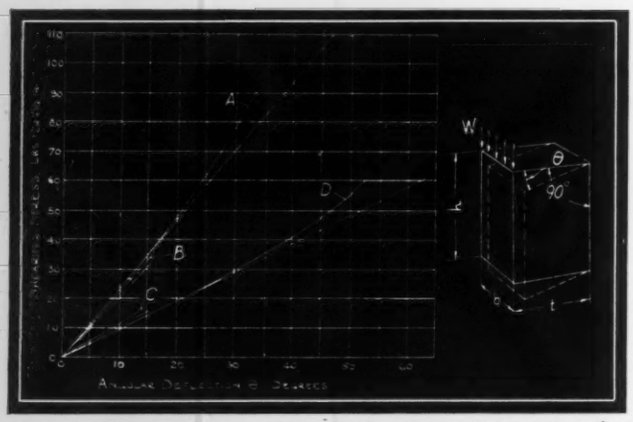
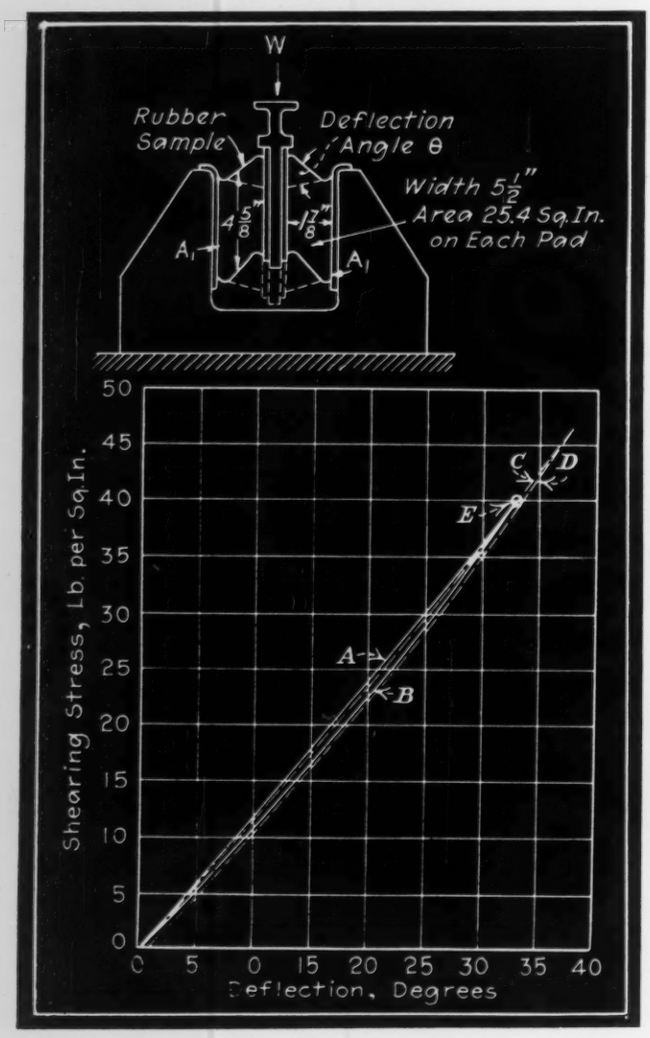


Fig. 1—Above—Agreement of theory and practice for several rectangular rubber slabs. Solid curves are experimental, dot-dash curves calculated. Fig. 3—Below—Simple double sandwich, A and C being first and second loadings, B and D unloadings. A, B, and C meet at E



IN LINE with the rapidly growing use of rubber and rubber-like materials for industrial purposes, designers find themselves dealing with rubber mountings of all sorts. Because comparatively little data is available to aid in this type of design problem, this and a following article aim to supply useful information. Theoretical analyses for shear loading will be discussed in this instalment; empirical relationships for compression loading of rubber will be covered in the next.

It is not difficult to predetermine with reasonable accuracy the deflection to be expected from any ordinary rubber sample when it is loaded in shear. Sev-

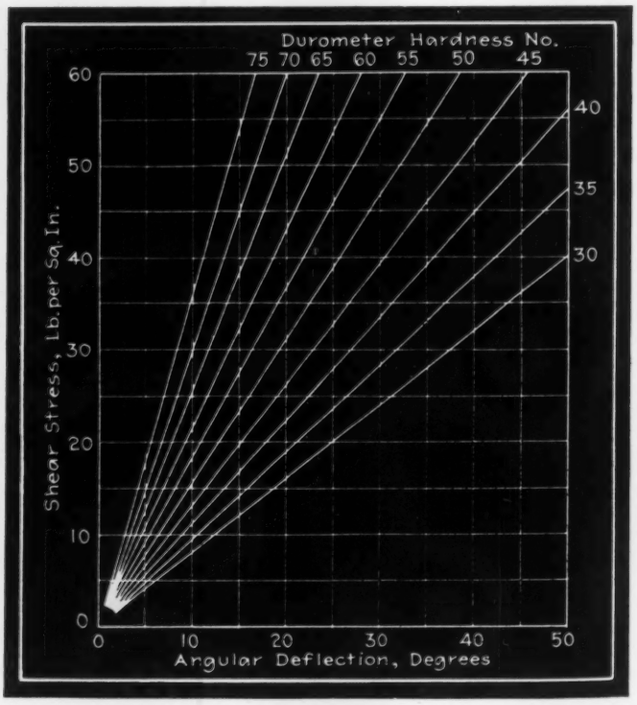


Fig. 4—Deflection of rubber in shear for any given stress and rubber hardness may be obtained quickly from chart

Rubber Mountings

Part I—Shear

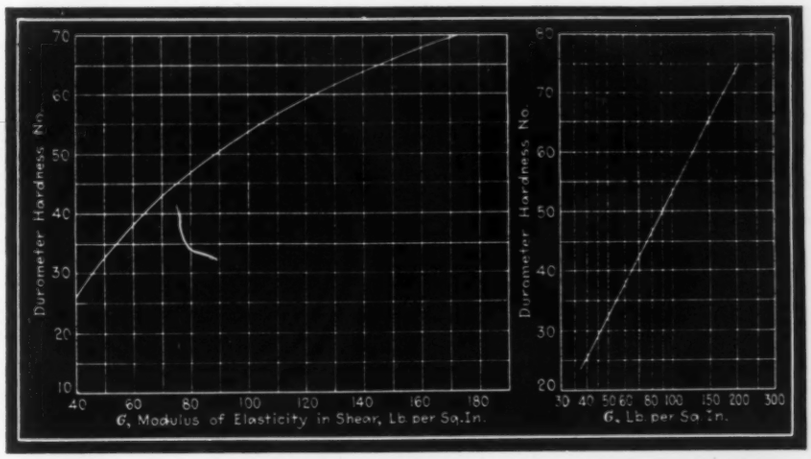
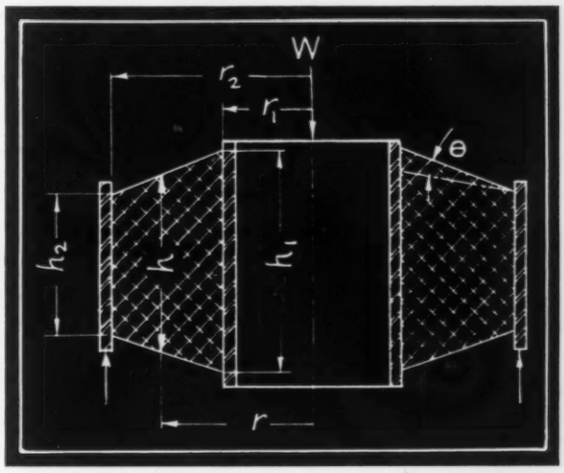


Fig. 2—Above—The modulus of elasticity in shear for any rubber can be found from the above, provided the durometer hardness number is known

Fig. 6—Below—Curve for cylindrical bushings when height of rubber varies linearly with the radius



eral common shapes have been investigated and the agreement of the theoretical curves with experiment is shown in the following figures. In every case discussed, unless otherwise stated, the rubber is vulcanized to metal plates.

SIMPLE SANDWICH. *Fig.* 1 shows the agreement of theory and practice for several rubber slabs of rectangular shape varying in hardness from 35 to 60 dur-

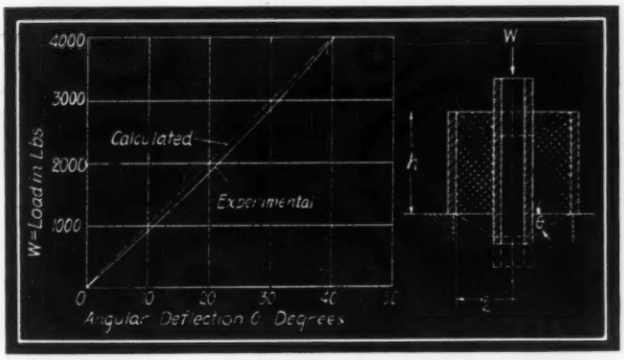


Fig. 5—With cylindrical bushings, shearing angle is constant with constant shear stress. Here are curves for a constant height of rubber

ometer, in thickness from ¾-inch to 3 inches and in loading area from 3.6 square inches to 31 square inches. If instability does not enter the picture the same theoretical treatment can be used for any cylindrical shape, whether rectangular or not. Values for factors of the four experimental curves are: *A*, $b = 3$ inches, $t = 3$ inches, $h = 8$ inches, area = 24 square inches, duro 60; *B*, $b = 7.87$ inches, $t = 1.77$ inches, $h = 3.94$ inches, area = 31 square inches, duro 58; *C*, the same as *B*, except for duro 38; *D*, $b = 12$ inches, $t = ¾$-inch, $h = 3$ inches, area = 3.6 square inches, duro 35. In the cubical drawing, θ is the angle of deflection, 90 degrees the unloaded angle.

The definition of strain is variously given as (a) the tangent of the angle, or (b) the angle in radians. Because the latter gives rather better agreement of theory and practice it is the one adopted by the author, and gives equations (1) and (2).

$$\text{Strain (in radians)} = \frac{W}{AG} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

or

$$\text{Strain (in degrees)} = 57.3\frac{W}{AG} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where

W = load applied as shown in *Fig.* 1.
A = area of loading surface = bh of *Fig.* 1.
G = modulus of elasticity in shear for the rubber used.

The modulus of elasticity in shear for any rubber

NOMENCLATURE

Symbol	Definition	Units
A	Loading Area	sq. in.
b	Width	in.
D	Deflection	in.
E	Modulus of Elasticity in Shear	lbs. per sq. in.
G	Modulus of Elasticity in Compression	lbs. per sq. in.
h	Height	in.
l	Length	in.
r	Average radius	in.
r_1	Radius to inner surface of rubber	in.
r_2	Radius to outer surface of rubber	in.
R	Ratio of long side to short side of slab	
S	Stress in rubber	lbs. per sq. in.
T	Torque applied to mounting	lb-in.
W	Load	lbs.
θ, ϕ	Angular movement	rad. or deg.

can be found from *Fig.* 2, provided that the durometer hardness number is available. The durometer is a commercial instrument commonly used for getting rubber hardness, but any other acceptable method of obtaining the shear modulus of elasticity would obviously yield the same results, and would not affect the theories involved in the following analyses, which are representative.

COMPOUND SANDWICHES. A simple double sandwich is shown in *Fig.* 3, and the load deflection diagram shows the close agreement of theory and practice. This also shows that some variation is to be expected from the first to the second loading. A and C represent the first and second loadings, B and D the first and second unloadings, E the point where A, B, and C meet.

The theory involved is the same as that given in equations (1) and (2). Naturally, in this case the load is distributed over both sandwiches, so that if a symmetrical design is made, each side takes one half of the load.

It is clear that for increased deflection over that obtainable with a simple compound sandwich, additional slabs may be placed in series. Caution should be taken that this process is not carried too far, or instability will result. In particular it may be pointed out that the height should be large compared with the thickness.

It is customary when using plain sandwiches to supply compression to the slabs before loading them in shear. This compression ordinarily amounts to 5 or 10 per cent of the free thickness of the rubber. All calculations for deflection caused by shear loading, however, are to be based on the free thickness of the rubber. It has been found experimentally that a compression of 10 or even 20 per cent of the original thickness has no appreciable effect on the shear load-deflection curve for the uncompressed slab. In order to calculate the deflection of rubber in shear quickly, *Fig.* 4 has been developed. By its means the deflection for any given stress and rubber hardness can be obtained.

CYLINDRICAL BUSHINGS. (a) With constant shear stress, the shearing angle ϕ is also constant. In this case, stress =

$$\frac{W}{2\pi r h} = \frac{W}{2\pi r_1 h_1} = \frac{W}{2\pi r_2 h_2} = G\phi \quad \ldots\ldots\ldots\ldots (3)$$

Thus rh = constant, which is the equation of a hyperbola. The deflection can be obtained from ϕ and the physical dimensions of the bushing.

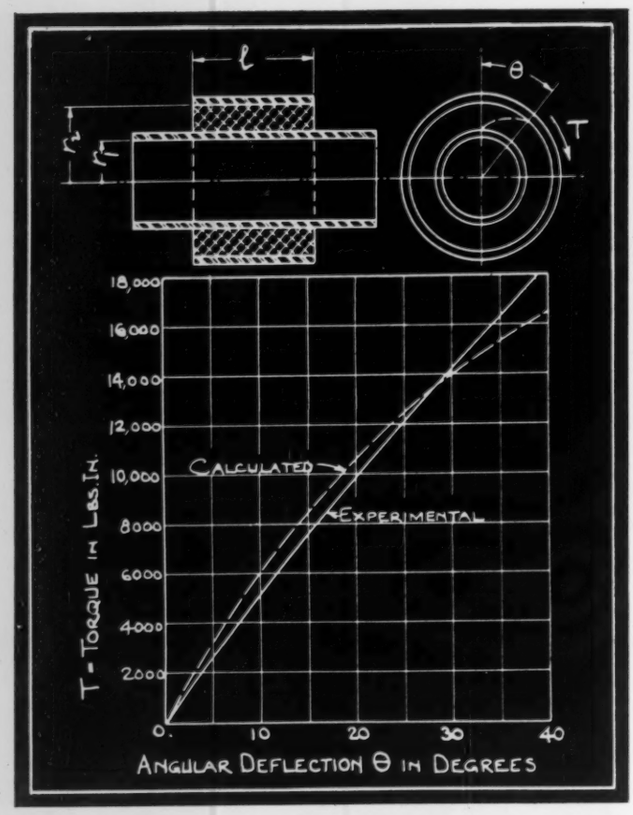


Fig. 7—In the case of a coaxial tube of constant length, this is agreement of theory and practice for a bushing

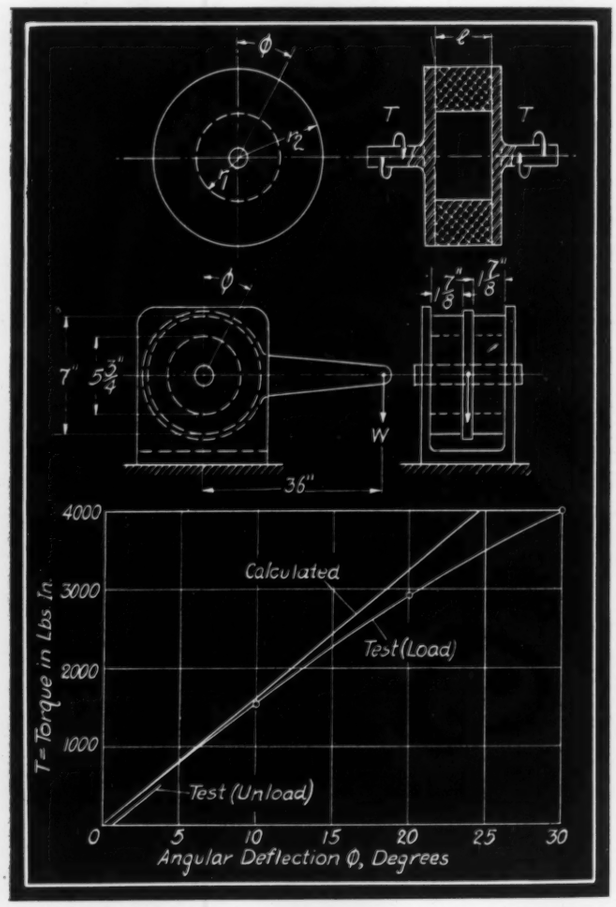


Fig. 8—A remarkably close approach of the calculated or unbroken curve to the experimental or dotted curve. The short line is experimental for unloading

(b) With constant height of rubber. *Fig.* 5, it can be shown that a first degree of approximation yields

$$\theta = \frac{W}{2\pi h G (r_2 - r_1)} \log_e \left(\frac{r_2}{r_1}\right) \quad \ldots\ldots\ldots\ldots (4)$$

The agreement of theory and practice for a particular

sample is shown in *Fig.* 5, in which $h = 5$ inches, $r_1 = 2$ inches, $r_2 = 2\frac{7}{8}$ inches.

A second method of attack yields a more complicated result.

$$D = \frac{W}{2\pi h G} \log_e \left(\frac{r_2}{r_1}\right) + \frac{1}{6}\left(\frac{W}{2\pi h G}\right)^3 \left(\frac{1}{r_1^2} - \frac{1}{r_2^2}\right) + \frac{1}{30}\left(\frac{W}{2\pi h G}\right)^5 \left(\frac{1}{r_1^4} - \frac{1}{r_2^4}\right) + \ldots\ldots\ldots (5)$$

where D = deflection of the load.

(c) With height of rubber varying linearly with

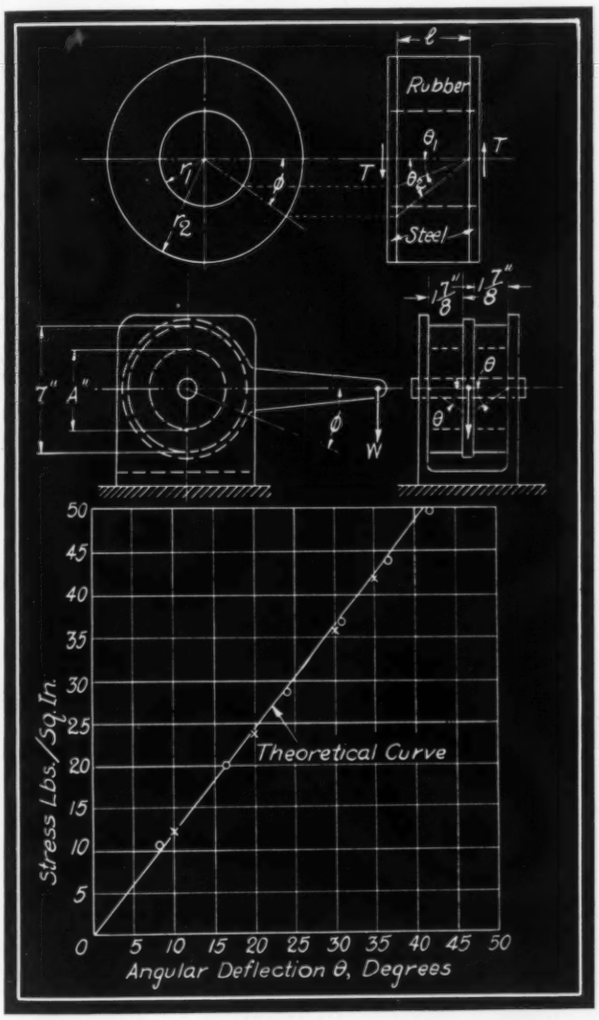


Fig. 9—A simple solution of a special case of a circular doughnut sandwich used in angular shear

the radius, as in *Fig.* 6, a first degree of approximation gives us

$$\theta = \frac{W}{2\pi G (h_1 r_2 - h_2 r_1)} \log_e \frac{r_2 h_1}{r_1 h_2} \ldots\ldots\ldots\ldots (6)$$

A much more complicated equation can be developed as in case (b) for deflection, but at the moment sufficient data is not available to justify elaboration.

COAXIAL TUBE OF CONSTANT LENGTH. In this case

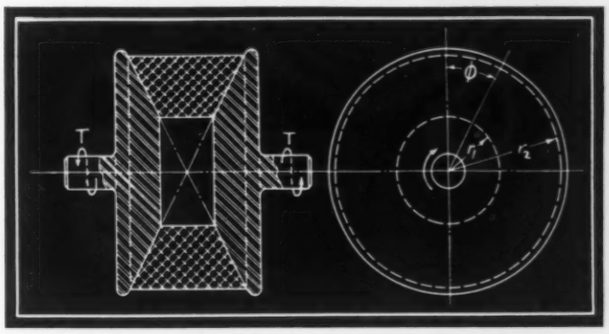


Fig. 10—Proper design of a rubber torsion bushing for angular shear should have conical faces, to stress equally

the angular movement can be calculated thus:

$$\theta = \frac{T}{4\pi l G}\left[\left(\frac{1}{r_1^2} - \frac{1}{r_2^2}\right) + \frac{1}{9}\left(\frac{T}{2\pi l G}\right)^2 \left(\frac{1}{r_1^6} - \frac{1}{r_2^6}\right) + \ldots\right] \ldots (7)$$

Fig. 7 shows the agreement of theory and practice for a particular bushing, where $l = 5$ inches, $r_1 = 2$ inches, $r_2 = 2\frac{7}{8}$ inches.

COAXIAL TUBE OF CONSTANT STRESS. The theory involved yields:

$$\theta\ (rad.) = 2.3026 \log_{10}\left(\frac{r_2}{r_1}\right) \tan\left(\frac{T}{4\pi G r_2^2 l_2}\right) \ldots (8)$$

$$or\ \theta\ (deg.) = 132 \log_{10}\left(\frac{r_2}{r_1}\right) \tan\left(\frac{T}{4\pi G r_2^2 l_2}\right) \ldots (9)$$

Unfortunately the author has no experimental data to check the theory.

CIRCULAR DOUGHNUT SANDWICH USED IN ANGULAR SHEAR. (a) For small deflections

$$T = 0.0274 \frac{G\phi}{l}(r_2^4 - r_1^4) \ldots\ldots\ldots\ldots (10)$$

(b) For large deflections

$$T = \frac{2\pi G}{3}\left[r_2^3 \tan^{-1}\left(\frac{r_2\phi}{l}\right) - r_1^3 \tan^{-1}\left(\frac{r_1\phi}{l}\right)\right] - \frac{\pi G l}{3\phi}(r_2^2 - r_1^2) + \frac{\pi G l^3}{3\phi^3} \log_e \left[\frac{1+\left(\frac{r_2\phi}{l}\right)^2}{1+\left(\frac{r_1\phi}{l}\right)^2}\right] \ldots\ldots (11)$$

Equations (10) and (11) are the basis for the two theoretical curves shown in *Fig.* 8, where the area of two pieces of 43 duro rubber is 25 square inches. The close agreement of the experimental points, shown by curve with dots, and the theoretical equation for large movements, the unbroken curve, is remarkable. Short line is an experimental curve for unloading.

(c) In a special case, with $(r_2\text{-}r_1)$ small compared with r_2 a satisfactory solution can be obtained.

$$T = \frac{\pi}{2} G\theta (r_1 + r_2)^2 (r_2 - r_1) \ldots\ldots\ldots\ldots (12)$$

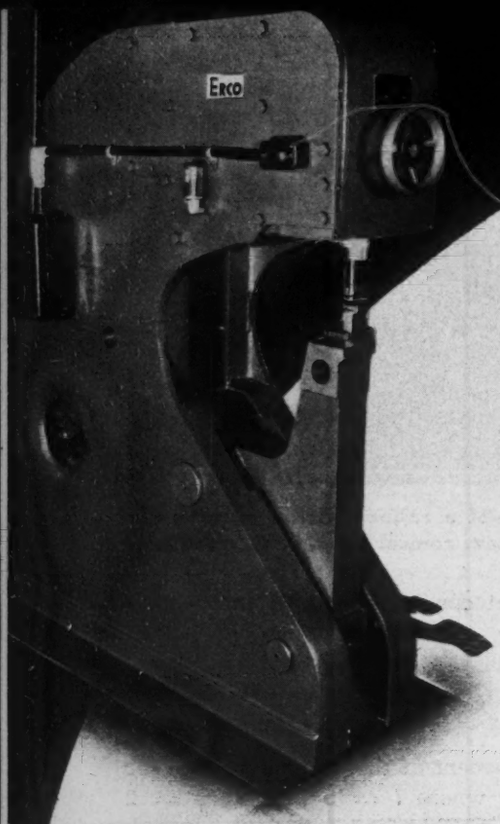
$$and\ \tan\theta = \frac{r\theta}{l} \ldots\ldots\ldots\ldots (13)$$

$$and\ S = G\theta \ldots\ldots\ldots\ldots (14)$$

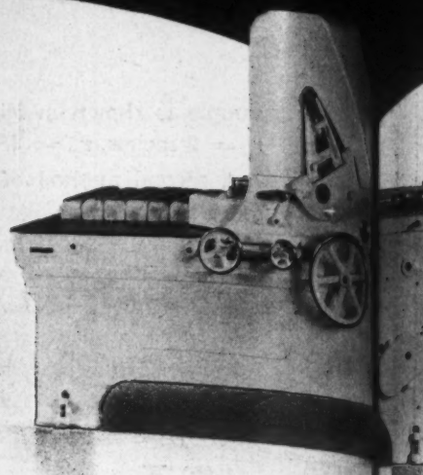
Where S = average stress in the rubber.

and $r = \frac{1}{2}(r_1 + r_2)$

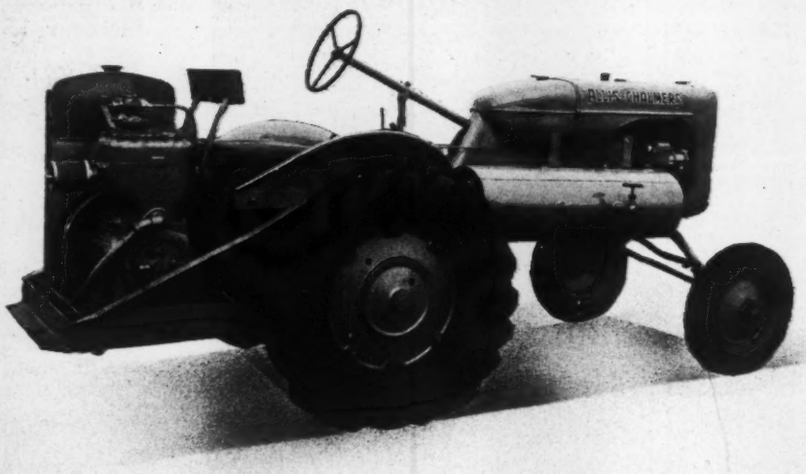
(Concluded on Page 64)



Completely self-contained, the Erco sheet metal shrinker (left) has an upright welded steel frame with a cast crankcase in its upper end. An electric motor mounted within the back of the frame, drives the mainshaft through V-belts. A reciprocating ram moves vertically in a bearing at the forward end of the crankcase. Oil is maintained at a constant level by an automatic feed. Work is compressed when the stroke of the ram forces the jaws to slide down inclined surfaces of anvils

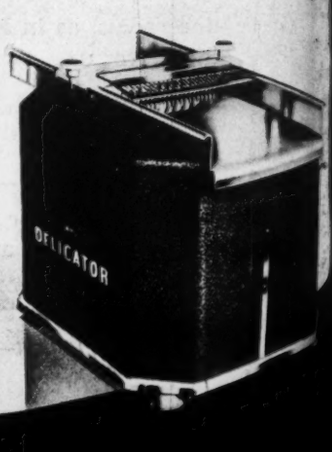


A water-cooled Quincy portable air compressor has been mounted on an Allis-Chalmers tractor (right) to permit maximum availability. The compressor may be quickly dismounted if the tractor is needed elsewhere. Air receiver tank, mounted on the right side of the tractor, is built for a working pressure of 150 pounds. Compressor piston displacement is 80 feet per minute maximum. Power is provided by a four-cylinder tractor engine with a rear power takeoff and clutch type pulley for compressor operation



Oakes & Burger can washer (below) employs a one-horsepower motor connected with a variable speed device driving the machine itself, another of 2-horsepower rating to handle rinse tanks and blower, and a 5-horsepower motor supplying power for the washing solution pump. Valves, dial thermometers, gages and motor controls are conveniently arranged for the operator. Armco iron is used for the smooth exterior

All-electric, the U. S. Slicing Machine Delicator (right) has a series of 58 sharp blades which penetrate meat completely, in criss-cross fashion, to tenderize it. All parts in contact with meats are stainless steel. A 1/6-horsepower motor powers the machine. Wrinkle finish is used for the remainder of the exterior



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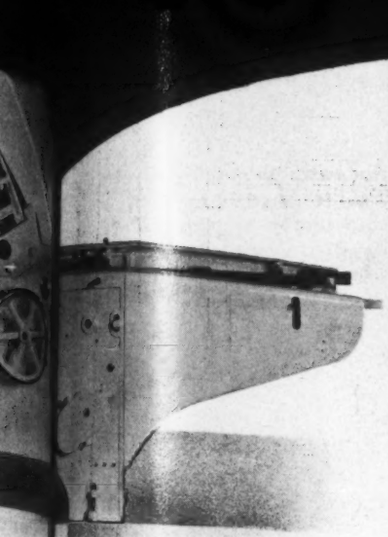
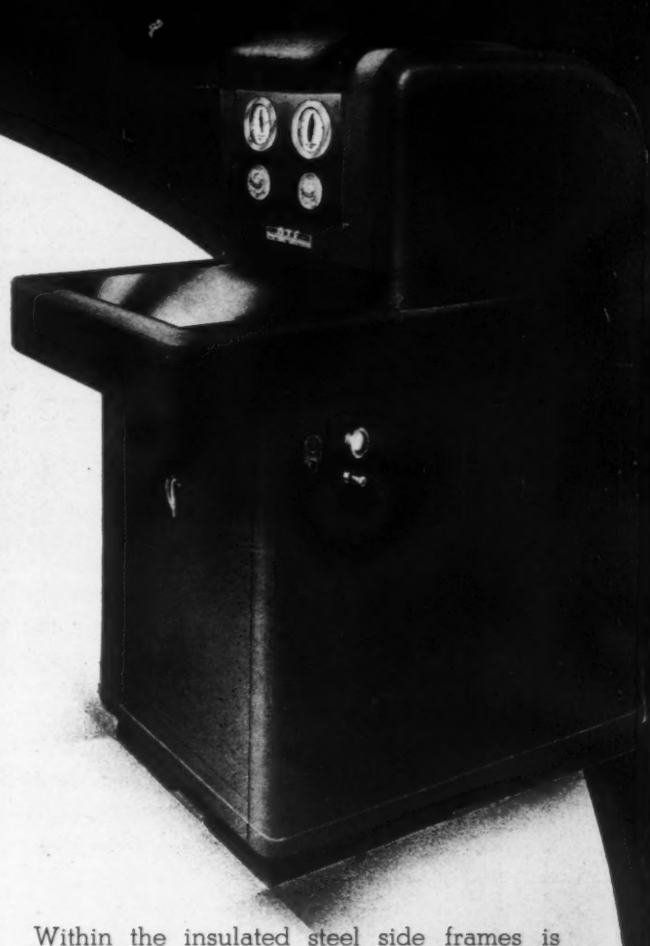


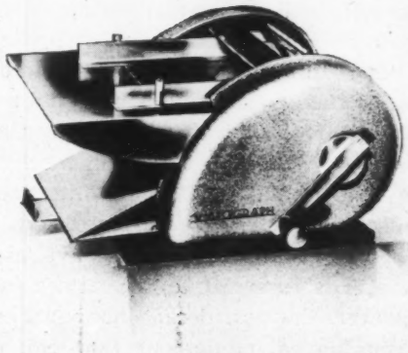
Loaves are handled on the Battle Creek band bread slicer (left) on a continuous level feed against endless band blades. A turn of a handwheel gives a wide range of slice thicknesses while the machine is running, through cast zinc alloy knife guides on a broached bronze nut operating over splined shafts. If a knife band breaks, a cutoff mechanism shuts off the motor. Blades are alloy steel



Features Machines

Presentation of Recent Ma-the Standpoint of Design

machine listing see page 97)

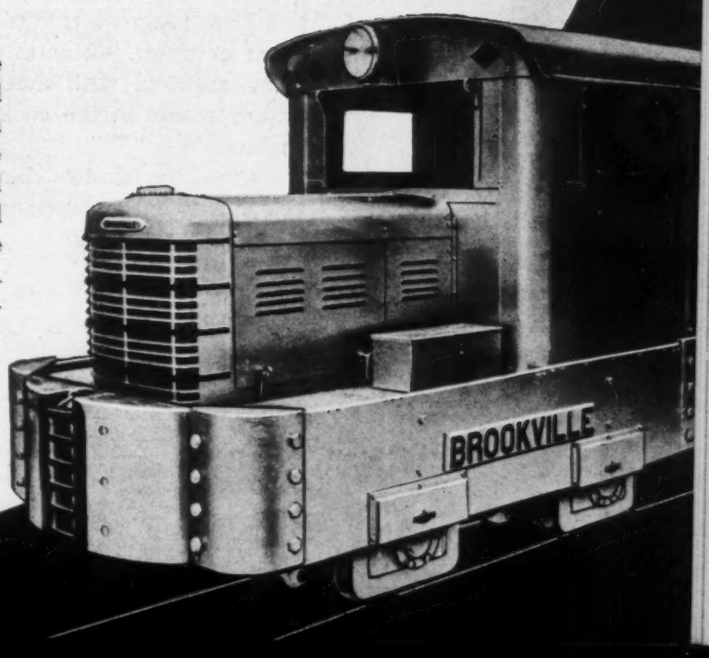


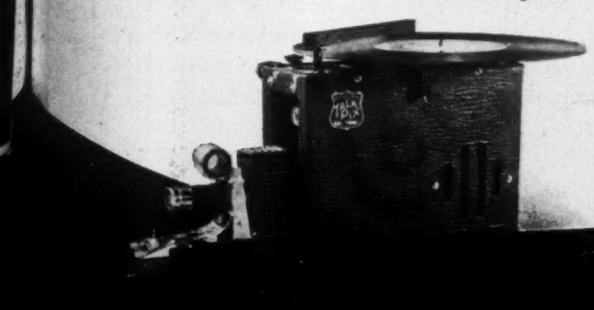
Within the insulated steel side frames is the hydraulic power unit of the Stereotype rubber printing plate vulcanizer (above). Controls are placed at one side at operator's hand level, while timing clock, thermostats and pressure gage are concentrated on an instrument panel at eye level. The panel is illuminated from above. The machine's body is completely enclosed in a box cabinet

ation sheet positioner and margin sets slightly above the drum periphery al mounting of the Victor duplicator led by Willis Ahlborn Kropp. The depresses into feeding position as it he platen roller, providing a smooth Sheets are straightened by rollers.

tor, amplifier and of the Talk-Pix ma- (below) are turned on aneously by a single control. Unnecessary ts have been eliminated simple exterior. An long pickup arm es record scratching

The Brookville industrial locomotive (right) is designed to use standard Ford power plants, including engine, clutch and transmission. To conform to the slight, but necessary, freedom in journal movement necessitated by curves and irregularities in track, roller chains are utilized for driving all wheels. A spiral reverse gear makes all four forward speeds available in reverse





Where Will Present Trend Toward Automaticity Lead Next?

WHEN a machine is being developed the designer has to take into account not only the performance expected of it but also the conditions under which it will operate. Will it be subject to the attention of an expert who can administer to its needs or must it run days, weeks or months unattended?

This point has influenced machine design more than is generally realized. For many years certain obvious improvements in railroad motive power were held back by the belief that the working parts of a locomotive should be so simple that repairs could be made in the crudest of remote back shops or roundhouses. The railroads also were slow to permit the introduction of alloy steel for certain locomotive parts because the chief mechanical engineers feared disaster if an alloyed part fell into the hands of a shop blacksmith unskilled in the special heat treatment required.

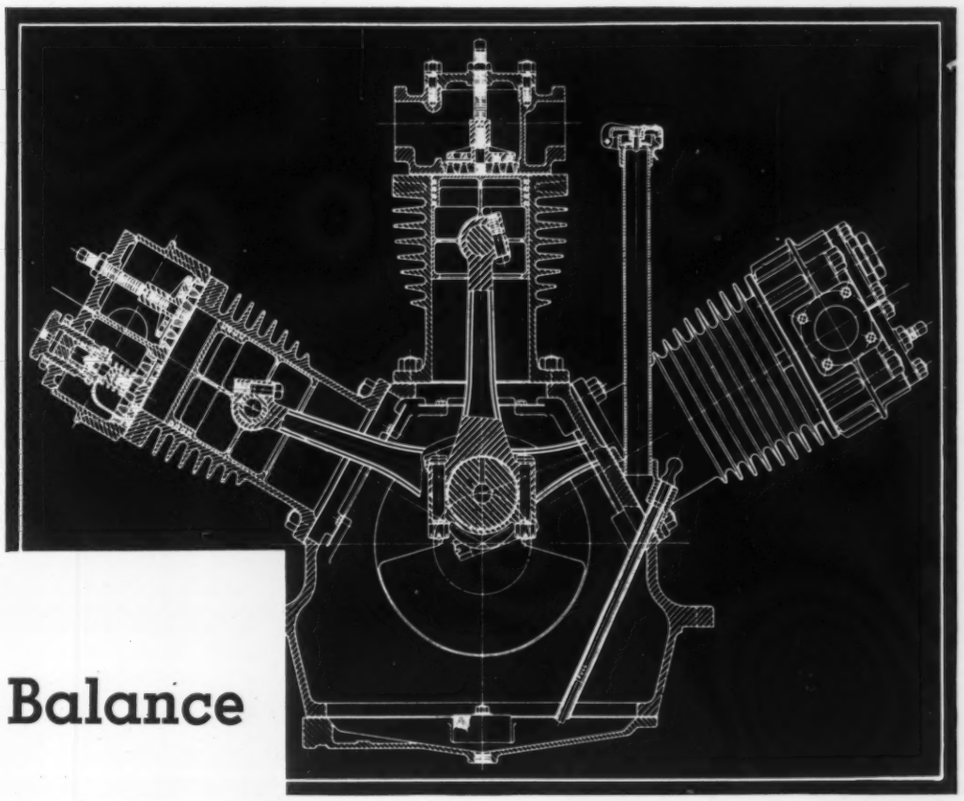
In a similar way, designers encountered strong opposition from vessel owners and operators when they tried to introduce steam turbines for ship propulsion. Any ship's chief engineer worthy of the name could effect repairs on a reciprocating engine sufficiently to enable a ship to make port. But how, they asked, could he repair an intricate turbine if it broke down in midocean?

Young engineers do not realize it, but the electric motors and internal combustion engines which are in such common use today did not have an easy time supplanting steam engines. At the turn of the century the maintenance crews of American industry were proficient in everything mechanical connected with steam. They knew little of electricity and less of internal combustion engines. They distrusted both, and at first resented their intrusion.

Today the presence of a skilled operator or the availability of expert repair and maintenance service still is essential to the successful operation of many types of machinery. However, the past decade has witnessed a spectacular advance in the design of mechanical equipment that can operate long periods with little or no attention. Mechanical refrigerators—once subject to considerable maintenance—now are manufactured with all moving parts sealed in so that no lubrication, adjustment or other attention is required. This is typical of the trend in many lines of mechanical equipment designed for home use.

New progress toward automaticity in some machines now requiring frequent or semifrequent attention seems assured. For instance, experience now being acquired with aviation engines in transoceanic service should lead to improvements in the cooling, bearings and lubrication of internal combustion engines.

Can it be possible that such progress in the air eventually will result in developments on land that will relieve us of the necessity of changing our motor oil every 2000 miles?



Cross-section through a two-stage, three-cylinder air compressor whose single throw crankshaft is balanced dynamically

Dynamic Balance For a Crankshaft

THREE distinct purposes influenced dynamic balancing of the single throw crankshaft in the Le Roi air compressor shown in the illustration. This compressor is the three-cylinder radial air-cooled type which has circular, graduated fins arranged to give maximum heat transfer at the top of the cylinder and uniform expansion over the entire length of the cylinder.

To obtain static balance within the crankshaft, counterweights equal to the weight of the chankshaft cheeks and crankpin are added opposite the cheeks at crank radius. Center of gravity of the crankshaft is thus shifted to its axis of rotation. Since a couple is created, the shaft is also dynamically balanced within itself.

In balancing inertia force caused by reciprocating parts—piston, rings, piston pin, and approximately one-third of the connecting rod—the force is expressed by the formula

$$F = \frac{WrN^2}{35{,}240}\left(Cos\,\theta + \frac{r}{R}Cos\,2\theta\right)$$

where W is the weight of the reciprocating parts in pounds, r is the crank radius in inches, N is the revolutions per minute, R is the length of the connecting rod from center to center in inches, and θ is the angle through which the crank rotates. For any specific case $WrN^2/35{,}240$ becomes a constant K, so $F = K\ \text{Cos}\ \theta + Kr/R\ \text{Cos}\ 2\theta$. The first term, K Cos θ, represents the primary unbalanced force, while the second term Kr/R Cos 2θ is the secondary unbalanced force.

It is impossible to counterbalance the second and higher harmonics with weights rotating at crankshaft speed, since their period is shorter than that of crankshaft rotation. A vector analysis of the primary harmonic of inertia forces proves that by adding a counterweight equal to one-half the reciprocating weight of each cylinder opposite the crankpin and at crank radius the primary harmonic is completely balanced.

Increased bearing pressure caused by the essentially rotating motion of the lower end of the connecting rod must be offset. This was accomplished by adding to the counterweight a weight equal to the weight of the lower end of the connecting rods placed opposite the crankpin and at crank radius. Centrifugal force produced by these rotating parts is also balanced by this weight.

Before the crankshaft can be placed in the balancing machine a dynamically balanced collar is fastened to the crankpin. This collar then has a moment equal to the moment of the counterweights. In other words, it is the equivalent of the moment produced by the rotating and reciprocating parts concentrated at the crankpin center.

Men of Machines

G. S. CRANE

ASSOCIATED with Cutler-Hammer Co. for twenty-nine years, serving successively in the engineering and sales department, G. S. Crane has been appointed vice president in charge of sales and engineering. In this new position, he has supervision of all the company's development work as well as executive control of engineering, drafting and patent departments.

Having had considerable experience in the selling field, Mr. Crane is in an excellent position to aid the engineering department in designing the type of equipment required by industry. His work in the electrical field is well known. At the present time he is chairman of the advisory committee, Industrial Control Section of National Electrical Manufacturers' association. Previous to his recent appointment Mr. Crane was vice president in charge of sales.

C. H. HALL

APPOINTMENT of C. H. Hall, formerly designing engineer, as chief engineer of the stoker division of Fairbanks, Morse & Co., Chicago, has been announced.

Mr. Hall began his engineering career in the engineering department of Robbins & Myers as assistant chief draftsman. Leaving this company, he joined Gillespie-Eden Corp. as chief draftsman. There he redesigned the company's line of washing machines and other household appliances. From household appliances his interest broadened to that of developing automatic mechanical stokers for domestic and small industrial plants for the Domestic Stoker Co. of New York. While there as chief engineer he designed and developed an automatic anthracite burner. A little over two years ago he joined Fairbanks, Morse & Co. in its stoker division as designing engineer.

ROBERT K. JACK

WITH considerable motor car engineering experience obtained through his many connections in the industry, Robert K. Jack is enabled to fulfill more than adequately his new duties as chief engineer for Reo Motor Car Co.

Graduated from Royal Technical college, Glasgow, Mr. Jack served an apprenticeship with Argyll Motors Ltd. in both shop and drafting room. He is credited with having designed, under Henry Perrot, the 15-horsepower Argyll single sleeve engine which made a record on the track. Then for two years he was designer, checker and assistant engineer of Cadillac Motor Car Co., and assisted in the design of the first 8-cylinder Cadillac engine.

Later, as chief engineer of Russell Motor Car Co., he was in charge of

NEW

SLEEVE BEARING DATA SHEETS

for the

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● Here are valuable additions to your file folder on Sleeve Type Bearings. New data sheets dealing with Tolerances and Oil Clearances have just been produced. They will serve you as a guide when deciding your bearing specifications.

Sleeve bearings of today are precision-made products. They more than prevent wear and reduce friction — but definitely aid the performance of the motive unit. Accordingly, they should be designed and produced to fit the individual application. You can easily eliminate guesswork and effect marked economies in selecting your requirements by knowing what factors to consider . . . which type to select. Johnson makes this an easy matter for you. Data sheets are available on such subjects as Alloys, Lubrication, Design, and on all types as — Cast Bronze, Sheet Metal, Laminated, Self-Lubricating Bearings.

This is but one of the many plus values we offer to industry. Competent Engineers and Metallurgists are always available to study your bearing problems. As producers of *all* types of sleeve bearings, we base our recommendations solely on facts . . . free from prejudice.

Why not take advantage of this exceptional service? Write today for a copy of our file folder. And when you have a bearing problem — invite a Johnson Engineer to help you solve it. There is no obligation involved.

Ask for the Complete Set

Sleeve Bearing Data Sheets come to you in loose leaf form — all in a handy file folder. This will fit right into a standard letter file and keep valuable bearing data — right at your elbow. Write for a complete set — today.

The MOST COMPLETE SLEEVE BEARING SERVICE in the world

JOHNSON BRONZE COMPANY

Sleeve BEARING HEADQUARTERS

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design and construction of armored trucks and portable machine shops for the Canadian Expeditionary forces. After the amalgamation of the Russell and Willys-Overland companies, he accepted the position of works manager of Arrol Johnston plant in Scotland, builders of aviation engines. Returning to the United States, he became connected with Olds Motor Works as motor engineer and designed an 8-cylinder motor which again was a record winner. Mr. Jack was then appointed chief engineer and held this position for seven and one-half years. He is said to have designed and built the first American four-wheel brake car which had Argyll-Perrot type brakes.

From 1930 to 1932 he was chief engineer of Durant Motors of Michigan, designing several models of cars and trucks for the company. After acting as consulting engineer, he joined Pratt & Whitney Aircraft as assistant engineer, and two years later in 1938, he became connected with Reo Motor Car Co. as motor engineer.

♦

W. NEAL GALLAGHER has been re-elected president of American Washer and Ironer Manufacturers association, Chicago. Mr. Gallagher is connected with Automatic Washer Co.

♦

CHARLES E. NEUDORFER has been made chief enginer of William B. Scaife & Sons Co., Oakmont, Pa.

♦

E. L. BARTHOLOMEW, who for the past 23 years has been connected with United Shoe Machinery Corp., Boston, has become chief engineer.

♦

HOWARD SIMPSON has recently been placed in charge of the engineering and development work on the new line of agricultural equipment of Detroit Harvester Co., Detroit.

♦

HENRY S. WASHBURN has been named president of the American Foundrymen's association. He is president of Plainville Casting Co., Plainville, Conn.

♦

HENRY A. WEYER has joined the Chambersburg Engineering Co., Philadelphia. He formerly was engineer connected with Nazel Engineering & Machine Works of that city.

♦

ERNEST T. WEIR, chairman of National Steel Corp., has been elected president of the American Iron and Steel institute, replacing TOM M. GIRDLER who had served two consecutive terms as the institute's head.

♦

PAUL A. CONDIT recently has become control engineer with Cooper-Bessemer Corp., Mt. Vernon, O.

♦

GARDNER POOLE has succeeded COL. CROSBY FIELD as president of the American Society of Refrigerating Engineers. GEORGE HULSE, chief engineer of Safety Car Heating & Lighting Co.; CHESTER LICHTENBERG, engineer of General Electric Co., Fort Wayne, Ind.; and DR. WILLIAM R. HAINSWORTH, vice president of Servel Inc., Evansville, Ind., are vice presidents of the society.

♦

W. J. O'NEIL has been named president of the Dodge division of Chrysler Corp. Mr. O'Neil came up through the ranks, beginning as a machinist's apprentice.

♦

C. J. MILLER, president of Fremont Foundry Co., Fremont, O., has been elected president of the Gray Iron Founders' society at the annual meeting held recently.

♦

DR. PAUL L. SMITH, who has been conducting technical research projects for the Porcelain Enamel institute since his original appointment in 1937, has been reappointed for 1939 as research associate. He is a member of the National Bureau of Standards, Washington.

♦

DR. HARRY A. SCHWARTZ, manager of research, National Malleable & Steel Castings Co., Cleveland, has been awarded the E. J. Fox gold medal of the Institute of British Foundrymen in recognition of his work in research developments in the field of malleable cast iron.

♦

WARREN H. MCBRYDE, consulting engineer in San Francisco, has been nominated president of the American Society of Mechanical Engineers at the recent meeting of the nominating committee.

♦

DONALD M. SIMMONS, chief engineer, General Cable Corp., New York, has been awarded an honorary degree of doctor of engineering by Princeton university. This degree was presented to Dr. Simmons in recognition of his achievements in the electrical industry.

♦

HARRY GARD KNOX has resigned as vice president in charge of engineering of Electric Research Products Inc., New York.

♦

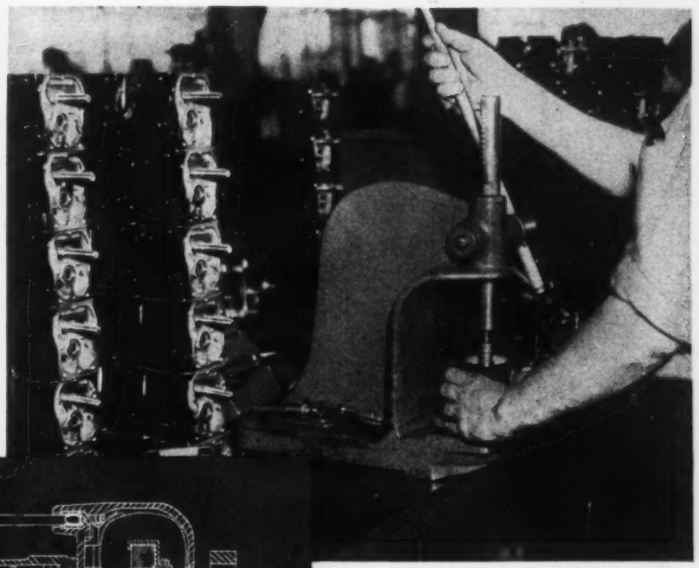
F. MALCOLM FARMER, vice president and chief engineer, Electrical Testing Laboratories, New York, was elected president of the American Institute of Electrical Engineers, according to a recent announcement made at the recent annual summer convention.

♦

CHARLES S. REDDING has been advanced from vice president in charge of research and engineering to president of Leeds & Northrup Co., Philadelphia.

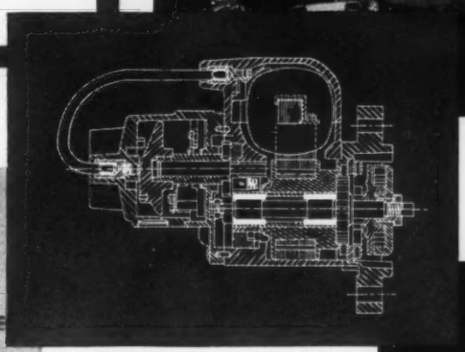
3 YEARS OF CONTINUOUS OPERATION

WITHOUT A SINGLE BEARING FAILURE!

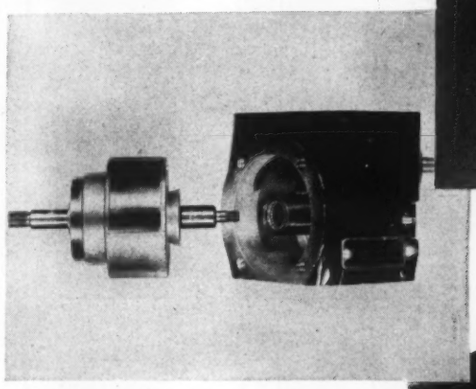


(*Above*) Torrington Needle Bearings are quickly installed in magnetos on the Wico assembly line.

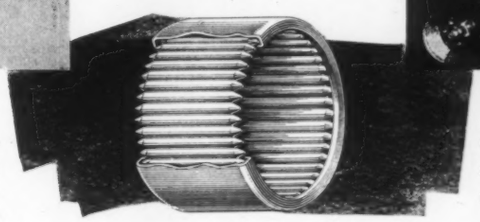
(*Left*) Cross section drawing shows the magneto and the location of the Needle Bearings.



(*Below*) Close-up view shows disassembled magneto unit, with Needle Bearing mounted in the housing.



(*Right*) The Offenhauser Racing Car motors equipped with the Wico Magneto, using Torrington Needle Bearings, operate in excess of 8,000 R. P. M.



THOUSANDS of Wico magnetos operating 24 hours a day have been in service for three years, or even longer—*without a single case of bearing failure!* That is the enviable record chalked up by the Wico Electric Company's magnetos in use in the oil field—and adequate testimony to the service-life of the Torrington Needle Bearings in the Wico magneto.

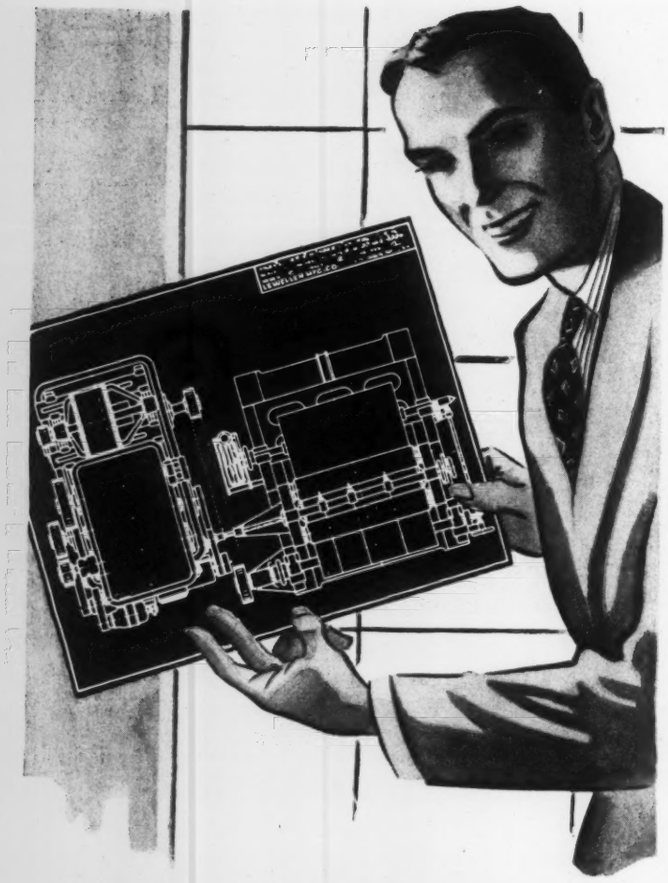
Performance like that is typical of the Torrington Needle Bearing—for it is engineered for long life under severe conditions. High radial load capacity at high speeds is one of the advantages of the Needle Bearing that contribute to its performance. Made with a full complement of rollers with a small diameter and long axis, the bearing provides many linear inches of contact—with resulting high capacity in even the smallest sizes. Efficient lubrication is another factor in bearing life. The hardened retaining shell of the bearing forms a reservoir for lubricant, holding plenty of grease or oil for long periods of operation, and the rotation of the rollers constantly supplies lubricant to the rotating shaft. When required by the application, the Needle Bearing can be readily adapted to gravity or pressure lubricating systems.

You can incorporate these advantages in your own product at very moderate cost. The simple design of the bearing makes possible a low unit price, and other economies result from the bearing's simplicity of installation. Because the Needle Bearing is built as a unit, it can be easily pressed into place in the housing—there are no loose parts to assemble. Moreover, the small size of the bearing often makes it possible to simplify the design of the housing, thereby saving space, weight, and cost in surrounding members.

The Torrington Engineering Department will be glad to work with you in adapting the advantages of the Needle Bearing to your products. For further information write for Catalog No. 9. For Needle Bearings to be used in heavier service, request Booklet 103X from our associate, the Bantam Bearings Corporation, South Bend, Ind.

The Torrington Company
ESTABLISHED 1866
Torrington, Conn., U.S.A.
Makers of Ball and Needle Bearings
Branch Offices in all Principal Cities

TORRINGTON
NEEDLE BEARING



OCCUPATION: **A Lewellen Representative**

DUTY: **To solve your speed control problems**

● And, what an *important* service to you! For, solving your speed control problems means *Increased Production* at *Lower Costs* and an *Improvement in the Quality of Your Product.*

Why not call a Lewellen Representative today? You'll have the assurance that your problem, large or small, is in the hands of the recognized leader in speed control engineering.

New catalogs describing Lewellen Variable Speed Transmissions and Lewellen Variable Speed Motor Pulleys are yours for the asking.

LEWELLEN MANUFACTURING CO., COLUMBUS, INDIANA

Lewellen knows speed control

●

LEWELLEN

Variable Speed { **TRANSMISSIONS** / **MOTOR PULLEYS**

Noteworthy Patents

Driveshaft Energizes Brake

TORQUE supplied by the driveshaft furnishes energy for operating motor vehicle brakes to any degree desired by operator from a device covered by patent 2,144,024. Illustrated in *Fig.* 1, this invention has been assigned to Bendix Products Corp. by Ludger E. La Brie.

Power takeoff is provided through worm and gear affixed to a short shaft. On the end of this shaft is

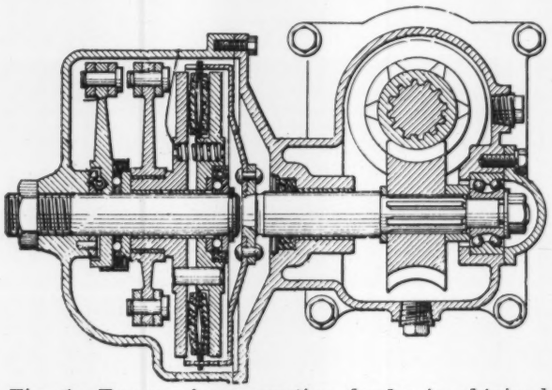


Fig. 1—*Torque for operating brake is obtained from friction disks driven from driveshaft*

a spider to which are attached two concave friction disks which have a limited axial motion. Another stub shaft is mounted in alignment with the first and carries activating lever, rocker arm for applying brakes and friction plates. All rotate on this shaft within their limits.

When the operating lever is moved it is thrust endwise by riding up on cam arrangement shown at the left. Suitable thrust bearings exert pressure on the plates against the friction disks. These disks rotated by the spider from the worm gear exert a torque on the plates. On them is mounted a rocker arm connected to the brakes on the wheels.

Joint Assembly Simplified

PRECLUDING the need for a spherical shell to hold members in place, a readily assembled universal joint shown in *Fig.* 2 has been designed by George W. Bill and assigned to the Bendix Products Corp. This design is covered by patent 2,156,106.

Interposed between the body members is a spherical shaped washer to hold them in assembled relation.

One Screw's "HEAT" is Another's "POISON"

SO WE SET UP THIS GUESS-STOPPER FOR HEAT TREATING

PRECISE
HEAT TREATING
for maximum strength with adequate ductility begins here. In this special lab furnace an individual routine for each small range of sizes and types is determined . . . then, carried through actual production under error-proof instrument control.

"16 POINT QUALITY-CONTROL" Leads Critical Buyers to Demand PARKER-KALON

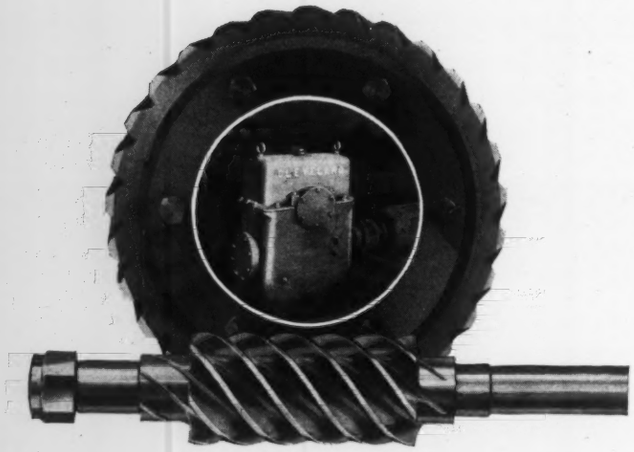
Heat Treating Control is only one of 16 checks on important characteristics of Parker-Kalon Cold-forged Socket Screws. In a laboratory without counterpart in the industry, quality is guarded by thorough tests and inspections covering:

1—Chemical Analysis. 2—Tensile Strength. 3—Ductility. 4—Torsional Strength. 5—Ability to take Shock Loads under Tension. 6—Resistance to Shock Loads under Shear. 7—Hardness. In addition, there is a rigid inspection of these essentials: 8—Head Diameter. 9—Head Height. 10—Concentricity of Head to Body. 11—Socket Shape. 12—Socket Size. 13—Socket Depth. 14—Centricality of Socket. 15—Class 3 Fit Threads. 16—Clean Starting Threads.

In this way Parker-Kalon maintains a new higher standard of quality in Socket Screws . . . a standard that satisfies the most critical buyer. Send for free samples . . . . see for yourself.

PARKER-KALON CORPORATION, 212 Varick Street, New York, N. Y.

PARKER-KALON Cold-Forged SOCKET SCREWS



Cleveland Drives Make Machines Pay Back Faster

CLEVELAND Worm Gear Drives will make the machines you build, pay back faster by protecting against costly shut-downs—by increasing productive hours. Even under the heaviest shock loads, Clevelands deliver a continuous flow of power, day after day throughout the years.

Twenty-seven years' experience in successful applications to the heavy machinery of American Industry have led plant executives to *expect more* from Cleveland Worm Gear Drives.

By their inherent ruggedness and dependability resulting in freedom from failure or need for repairs —and through long years of continuous service— Clevelands have kept faith. They *have delivered more!*

A Cleveland Engineer will show how you can make *your* machines pay back faster in savings for their owners, by helping you to plan the Worm Gear application best adapted to your job.

The Cleveland Worm & Gear Company, 3275 East 80th Street, Cleveland, Ohio.

Affiliate: The Farval Corporation, Cleveland
Manufacturers of Centralized Systems of Lubrication

CLEVELAND WORM GEAR Speed Reducers

It provides for thrust or longitudinal pull without affecting the relative positions of the members while transmitting torque. To allow for assembly this ball washer is flattened on two sides so that the members may be placed in position respectively over the flattened area.

Then, with the ball rotated to lie within the recesses, a key locks it firmly in position. This key is inserted through the hollow shaft of the left member. The key shown consists of a sleeve which is press fitted within the ball extending between the spaced arms of the body members. It abuts against a washer, preventing the ball from tilting. Torque transmitting balls roll in the raceways to bisect substantially the angle between the driving and driven shaft. This type of design is readily disassembled for inspection purposes without damage to any of its parts.

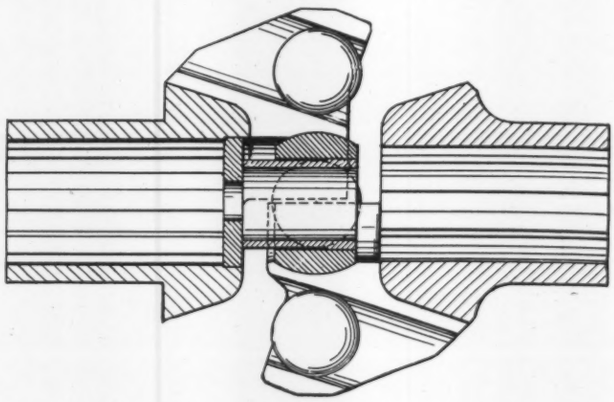


Fig. 2—Universal joint remains in assembled position without need for enclosing shell

Valve Regulates Fuel-Air Ratio

DESIRED regulation of carburetor choke valve in accordance with engine operating conditions is provided by the automatic choke valve illustrated in *Fig.* 3. It is designed so that when engine temperature is below a predetermined value it will supply a rich mixture until the engine begins to operate normally. This richness varies inversely with the temperature and speed. Also if engine tends to stall or the throttle is opened suddenly there will be a momentary increase in richness to insure smooth and rapid acceleration.

Through the opening in the top of the bellows connection is maintained with the intake manifold through a small opening in a poppet valve at lower left. Contraction by vacuum is limited by a pin positioned within the bellows. Likewise expansion is limited by the partition shown. The lower end of the bellows operates a lever controlling the choke valve in the carburetor. Also associated with this

FORMICA WHEELS
-FOR FACTORY TRUCKS!

FORMICA molded wheels for factory trucks provide an elastic, silent material that has unusual chemical inertness and resistance to injury by destructive materials used in many industrial processes. They stand mechanical wear exceptionally well, also. These wheels have made a record of unusual service in many difficult installations, and have reduced the cost of maintenance on factory trucks. They can be adapted to trucks of many types and sizes.

FORMICA

THE FORMICA INSULATION CO., 4632 SPRING GROVE AVE., CINCINNATI, O.

GREATER SAFETY and FREEDOM FROM BREAKDOWNS

Fig. 1645 Pat. Applied For

Fig. 1641 Pat. Applied For

When designing a product where ordinary set screws may vibrate loose, do as countless other firms are now doing . . . equip with

UNBRAKO

SELF-LOCKING HOLLOW SET SCREWS with the Knurled Points

These screws do eliminate one cause of machinery breakdowns and remove the danger of accidents caused thereby. The knurling around the points holds them securely in place so that once they've been tightened in the normal way they will not unwind and come loose unless a wrench is applied. Removal for adjustments is easily and quickly made and the screws reused indefinitely. Actual usage has proven their value. Write for details and samples.

. . . and wherever a square head set screw is subject to vibration use . . . UNBRAKO

SELF-LOCKING SQUARE HEAD SET SCREWS

These, too, are supplied with the knurled points that give them the added safety factor. In use they stay put, but can be removed without trouble and used over again any number of times. Ask us more about them.

Fig. 1646 Pat. App. For

STANDARD PRESSED STEEL CO.

BRANCHES BOSTON DETROIT INDIANAPOLIS

JENKINTOWN, PENNA. BOX 102

BRANCHES CHICAGO ST. LOUIS SAN FRANCISCO

control is a bimetallic coil spring adjacent to the exhaust manifold and operated by its heat.

On starting a cold engine, the bimetallic spring holds the bellows open. As the motor begins to operate vacuum tends to close the bellows and open the choke. With increasing temperature of the engine the spring begins to open and its resistance to closing

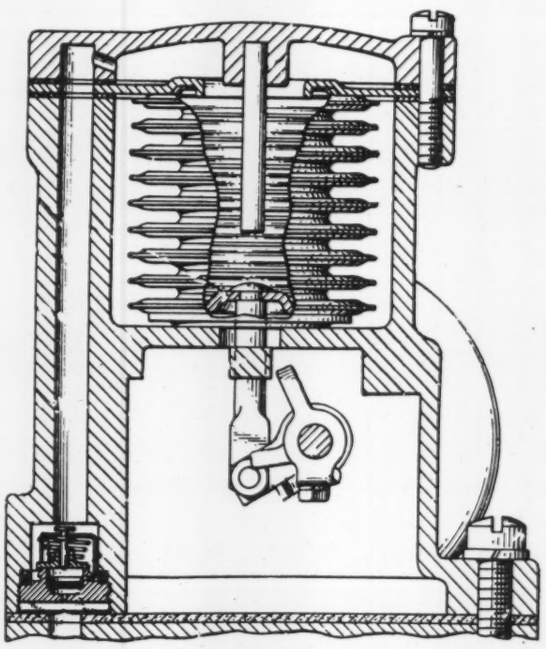


Fig. 3—Automatic choke valve varies gas mixture according to engine temperature and speed

the bellows lessens. Thus a normal gas mixture is approached.

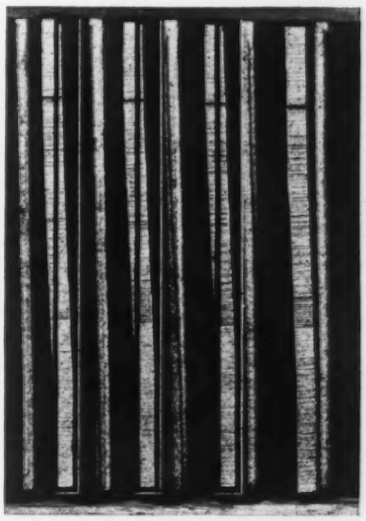
When the pressure in intake manifold increases, poppet valve is unseated and gases expand the bellows. Consequently, if temperature of engine is below a predetermined value and if throttle is opened, there will be a momentary increase in gas richness to prevent stalling and insure smooth and rapid acceleration. This valve, covered by patent 2,154,086, was designed by Jesse E. Eshbaugh and assigned to General Motors Corp.

Utilizes Diaphragms For Pump

DESIGNED to pump fluids with suspended solids, or chemicals and foodstuffs where possible contamination would be detrimental, a constant flow pump using six diaphragms driven from one crank pin has been patented by Henry H. Logan. Assigned to the Logan Engineering Co., this design as illustrated in *Fig.* 4 is covered by patent 2,146,123.

A vertical shaft, driven at reduced speed, revolves an eccentric pin. This pin moves in an orbit a floating ring which is free to revolve or not. Crosshead pins move radially in a groove in this ring to supply pulsations to the diaphragms, arranged concentrically about the crank. Each pump unit is driven from the

HARD-SURFACE TOUGH-CORE *perfectly joined in*



Teeth twisted .040" out of line with no sign of cracking or spalling. Solid black lines show original alignment of teeth before twisting.

Large section of fractured rim from S.A.E. 4615 "FIVE-POINT" DEEPHARD STEEL Timing Gear which was demolished in a breakdown test. Shows manner in which rim was bent and twisted to obtain smaller specimens.

Note the penetration of every fracture into and through the core without evidence of flaking and spalling.

'FIVE-POINT' *Deephard* STEEL

HERE is convincing proof of the remarkable fusion of the wearing surface hardness with the core — and of core ductility and toughness — that are found in all "FIVE-POINT" DEEPHARD STEEL products. The section of fractured rim illustrated above clearly shows the value of this ductility and toughness, and gradual and even fusion between surface hardness and core — without these qualities the teeth of this gear could not have withstood such distortion before fracturing . . . note that the fractures go into and completely through the core without flaking and spalling.

"FIVE-POINT" DEEPHARD STEEL *can be used and will do a better job wherever there is a problem of combating abrasive surface wear, shock and fatigue. It is a "hard surface" steel that is one "solid piece"— not a two-layer steel having a case and core.*

"FIVE-POINT" SUPERIORITY

1. **Increased hardness in wearing surface without fear of spalling or flaking.**
2. **Complete control of and greater depth to this hardness.**
3. **Gradual and even fusion of wearing surface with core.**
4. **Higher core area physical properties.**
5. **Metallurgically the finest grain structure throughout for wear, fatigue, and shock resistance.**

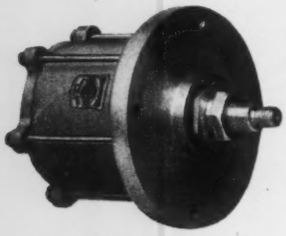
'FIVE-POINT' *Deephard* STEEL

Write today for catalog on "FIVE-POINT" DEEPHARD STEEL. Our engineering department is at your service in adapting this superior product to your problems of wear-life and strength.

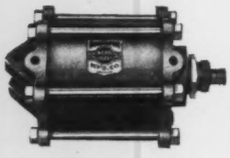
FOOTE BROS. GEAR AND MACHINE CORPORATION
5303 SOUTH WESTERN BOULEVARD CHICAGO, ILLINOIS

Better finish means better performance

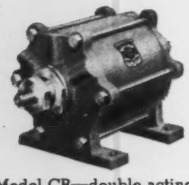
Hannifin Pneumatic Cylinders are bored and then honed on special Hannifin long stroke honing machines, producing a cylinder bore that is straight, round and perfectly smooth. Simple outside adjustment of the soft, graphite-treated piston packing allows the high efficiency piston seal to be easily maintained. These two features mean high efficiency air cylinder performance. Leakage and waste of air power is prevented; friction loss kept at the minimum.



Model JR—double acting air cylinder



Model BR—double acting air cylinder



Model CR—double acting air cylinder

Hannifin air cylinders are built in a full range of standard types, sizes 1½ to 16 in. diameter, for any length stroke. Larger sizes built to order. Single or double acting types, furnished with or without air cushion. Write for Bulletin 34-MD with complete specifications. Also Bulletin 35-MD describing Hannifin Hydraulic Cylinders.

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ENGINEERS • DESIGNERS • MANUFACTURERS
Pneumatic and Hydraulic Production Tool Equipment

HANNIFIN
high efficiency **AIR CYLINDERS**

same ring and pulsates in sequence to supply a constant flow. This also involves a constant drive load.

This reciprocating motion causes alternate collapse and expansion of the pump units. Intake and exhaust

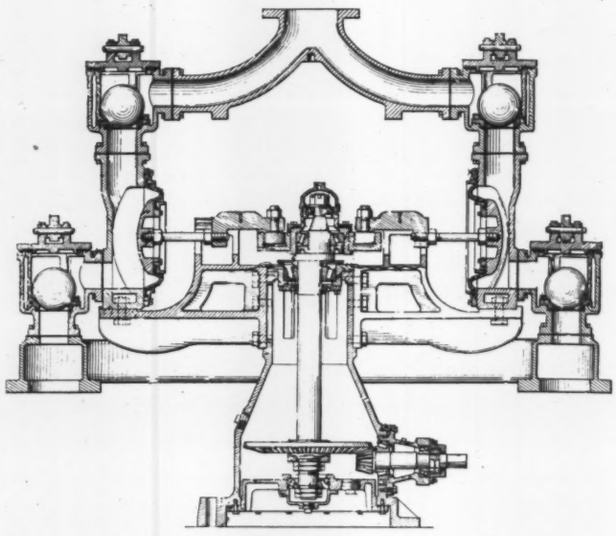


Fig. 4—Contamination of foodstuffs etc. is prevented in diaphragm pump

ball valves are positioned as shown to provide flow in one direction. The valves are rubber-covered with metal core, the metal comprising three-fourths of the radius. Heavier than the liquid being pumped, they will always seat by gravity. They are nevertheless unseated by air pressure when the pump starts.

Rubber Mountings

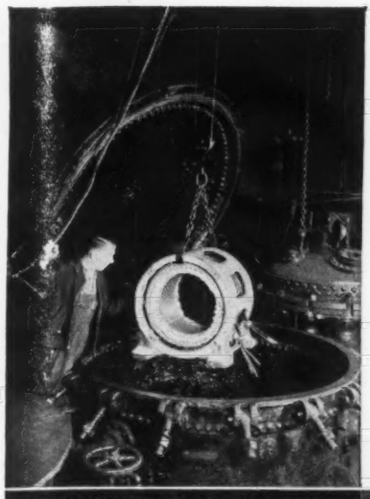
(*Concluded from Page* 49)

Fig. 9 shows that this simple solution gives satisfactory results for 43 duro rubber under the specified conditions. The X's represent experimental points when $A = 4\frac{1}{2}$ inches and the area of rubber, both sides, is 45.2 square inches. Dots are experimental points when $A = 5\frac{3}{4}$ inches and the area of rubber, both sides, is 25 square inches. The unbroken line is a theoretical curve when $A = 5\frac{3}{4}$ inches and $4\frac{1}{2}$ inches.

DOUGHNUT SANDWICH WITH CONICAL FACES. It is obvious that the proper design of a rubber torsion bushing for angular shear should have conical faces, so that all the rubber would be stressed to the same value. Such a design is shown in *Fig.* 10. For this case theory gives us:

$$T = \frac{2\pi G}{3}(r_2^3 - r_1^3)\tan^{-1}\left(\frac{r_2\phi}{l_2}\right) \quad \ldots\ldots\ldots\ldots\ldots (15)$$

Following these theoretical analyses of shear-loaded rubber mountings, a succeeding article will discuss compression loading from an empirical standpoint.



VACUUM IMPREGNATION

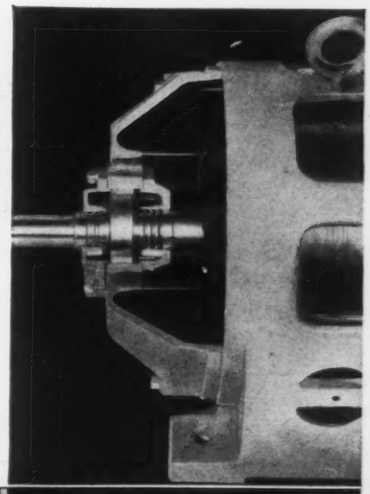
TWO FEATURES

exclusive with Crocker-Wheeler

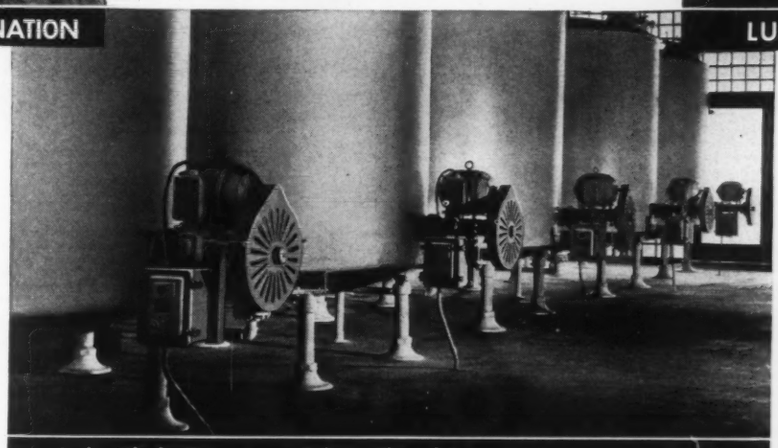
BUILD LONGER LIFE

into

GENERAL PURPOSE MOTORS



LUBRICANT SEAL



Crocker-Wheeler Motors in new Toiletries Plant of Campana Sales Co., near Batavia, Ill.

TYPICAL of Crocker-Wheeler pioneering and engineering are two construction features found in no other line of general purpose motors.

Vacuum Impregnation is commonly used in the construction of transformers, underground cables and other electrical apparatus, where it is vital to effect complete protection from dirt, oil and moisture. Crocker-Wheeler uses this process in the building of general purpose motors because it is the only process which eliminates the personal element in workmanship and offers complete assurance that all parts of the windings will be thoroughly insulated.

The patented frictionless *Lubricant Seal* for ball bearing motors prevents dust or other foreign matter from entering, and grease from leaking out of, the bearing housing. Many Crocker-Wheeler motors have run 5, 7 and even 10 years without the grease being changed.

●

WRITE FOR LITERATURE

Crocker-Wheeler makes a full range of squirrel cage and slip-ring motors. We would like to send you Bulletin No. 250 which describes in detail all the important construction features of Crocker-Wheeler A. C., Polyphase, Induction Motors. Please write on your business or professional letterhead for this Bulletin.

Write for illustrated data folders on any of the lines listed below

CROCKER-WHEELER

POLYSPEED MOTORS
1 TO 7½ HP.

DIRECT CURRENT MOTORS
½ TO 5,000 HP

POLYPHASE INDUCTION MOTORS
¼ TO 10,000 HP.

SYNCHRONOUS MOTORS
15 TO 10,000 HP.

CROCKER-WHEELER
TRADE MARK REG. U.S. PAT. OFF.

DIRECT CURRENT GENERATORS
UP TO 7,500 KW.

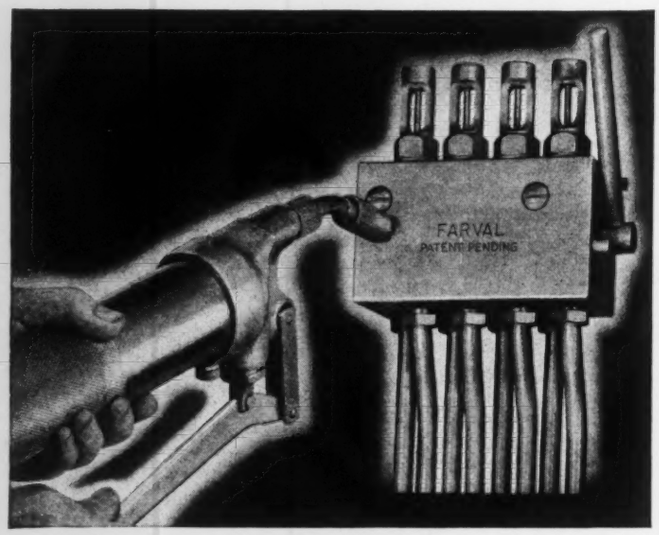
ALTERNATING CURRENT GENERATORS
UP TO 10,000 K.V.A.

MOTOR-GENERATOR SETS
UP TO 7,500 KW.

FLEXIBLE COUPLINGS
UP TO 200 HP.

50 YEARS OF PIONEERING

CROCKER-WHEELER ELECTRIC MFG. COMPANY, AMPERE, NEW JERSEY



put Positive Control

Between Pressure Gun and Bearings on the Machines You Build! . . . .

Install Farval DX Lubricating Blocks (Multiple Measuring Valves) on the machines you build, and your customers will never need guess how much lubricant—if any!—is delivered to the bearings.

Because—with the Farval DX Block, they can grease *several* bearings from one connection, giving every bearing an exact, measured amount, and have a tell-tale indicator to show the job is done. The amount delivered to each bearing is adjustable and—*not a bearing is missed.*

You can assure this positive control on your machines with the new Farval Multiple Measuring Valves. They are extremely simple in design; can be readily installed at nominal cost; and will last as long as the equipment you build.

Add to the value of your machines. Make them more salable.

Write for bulletin describing the new Farval DX Multiple Measuring Valve. The Farval Corporation, 3265 East 80th Street, Cleveland, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Manufacturers of Automotive and Industrial Worm Gearing

FARVAL

MULTIPLE MEASURING VALVE

NEW Materials and Parts

Drive Shuts Off at Overload

PROTECTION for agitators, mixers, conveyors or any equipment that might jam or become overloaded is provided by the new PlaneTorque MotoReduceR announced by Philadelphia Gear Works, Philadelphia. The motor is shut off automatically when the load exceeds a predetermined value. As soon as excessive load is removed, the unit is ready to start without resetting. This drive can be supplied for horizontal or vertical use in all horsepowers and ratios for industrial use. Whenever excessive torque is imposed on the output shaft of the PlaneTorque MotoReduceR, the increased torque required to rotate the plant gears mounted on the output shaft spider transmits a higher torque to the internal gear which is held in normal position by the lug and heavy spring. When the torque on the internal gear exceeds a predetermined value, the torque spring is compressed. This movement of the lug actuates the switch at the top, disconnecting the power. PlaneTorque MotoReduceRs can be supplied for horizontal or vertical drives in all horsepowers and ratios for industrial use, and may be furnished for clockwise or counter-clockwise rotation or both if reversing service is desired.

MotoReduceR provides protection for equipment by shutting off automatically when predetermined overload is reached

Offer Zirconium-Copper Concentrate

ZIRCONIUM-COPPER, a new material for improving standard brasses and bronzes, is now supplied in the form of a concentrate by P. R. Mallory & Co. Inc., Indianapolis. The concentrate has been found to be of particular advantage in producing nickel bronzes, increasing ductility substantially. The zirconium not only acts as a deoxidizer and scavenger of a melt, but when alloyed with manganese bronzes, aluminum bronzes and others, it gives increased hardness and tensile strength, higher thermal and electrical conductivity, and improved corrosion resistance. Two

Simplest, most economical means for connecting movable machine parts...

American Seamless Flexible Metal Tubing

Neat in appearance and dependable for carrying steam, gases and liquids under pressure, American Seamless is today the safest answer to flexible connector problems. It has a consistent record of satisfactory service in a long list of varied industries.

The modern engineer's choice for conveying steam, gases and fluids

It's easy to understand why design and maintenance engineers who are up-to-the-minute consistently choose American Seamless for either temporary or permanent flexible connections. For instance:

1. American Seamless has no welds, joints, seams or packing...it is as tight for the conveying of air, steam, gases and fluids as the seamless drawn tube from which it is made.

2. On several types of installations made in our laboratory, American Seamless has been flexed millions of times without breaking.

3. American Seamless will withstand high pressures dependent on the size of the tubing and number of wire braids. But as an example, consider $\frac{3}{8}$" I. D. tubing with two braids. Its hydrostatic bursting pressure is 6,000 pounds per square inch.

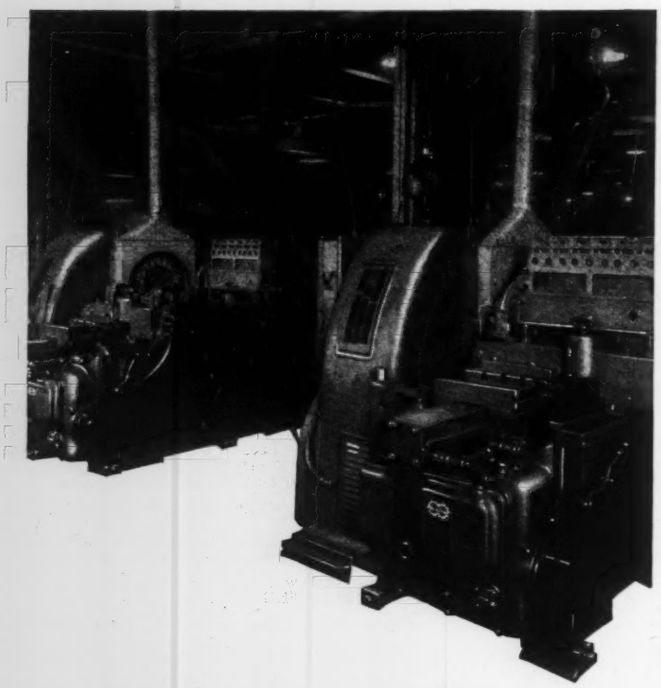
These and many other exclusive properties of American Seamless offer new ways to cut piping costs . . . to save assembling expense . . . conserve space. When you have a flexible connector problem, remember American Seamless and remember, too, our engineers. Both will help you solve it.

New 24-page manual now available. Ask for Bulletin SS-25.

American Metal Hose

ANACONDA
from mine to consumer

AMERICAN METAL HOSE BRANCH OF THE AMERICAN BRASS COMPANY
General Offices: Waterbury, Connecticut · Subsidiary of Anaconda Copper Mining Company
In Canada: Anaconda American Brass Ltd., New Toronto, Ont.



Putting a new design tool in your hands

● If you have a "white elephant" in the form of a tough problem of design long unlicked . . . if you feel the stubborn unyieldingness of conventional power means—try a new avenue of approach. Investigate thoroughly the unlimited interest and applicability of Oilgear Fluid Power.

Oilgear may give your machine a new motion . . . a new function, a new controllability of power or a surprising flexibility of its application—results that may mean a new high advantage in competitive markets. You will be surprised to know the great designers who already are taking advantage of Oilgear's *applicability* . . . and the results *they* have achieved. Start your investigation of this new tool *now*. THE OILGEAR COMPANY, 1321 West Bruce Street, Milwaukee, Wisconsin.

OILGEAR

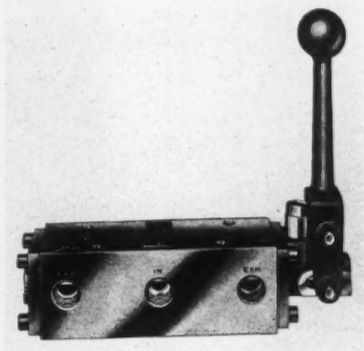
Fluid Power

VARIABLE SPEED SYSTEMS

standard concentrations, containing 12½ and 35 per cent zirconium, are supplied.

Valves Designed for Easy Servicing

WITH only one moving part, a new single plunger valve has been announced by C. B. Hunt & Son, Salem, O. Outlets and inlets in the sides permit servicing on the job without dismounting. Speed control of the piston is easily obtainable independently in either direction because of individual exhaust outlets con-



Single plunger valve with only one moving part has outlets and inlets in sides to permit easy servicing

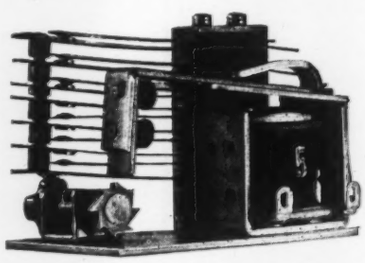
trolling each end of a double-acting cylinder. Of sturdy construction, the valve in most common sizes has extruded brass housings. Lubrication problems are obviated because there is no metal-to-metal contact. The seal increases with higher pressure. Twenty-five styles are available, in sizes from ⅛-inch to 1½-inch.

Nonmetallic Bearings Improved

IMPROVED nonmetallic bearings containing a special patented material known as Gatke Tuftex are announced by the Gatke Corp., Chicago. These bearings are molded under terrific pressures, producing a hard surface which cannot score journals. The dense but resilient structure withstands pressures and shocks that reduce the life of bearings.

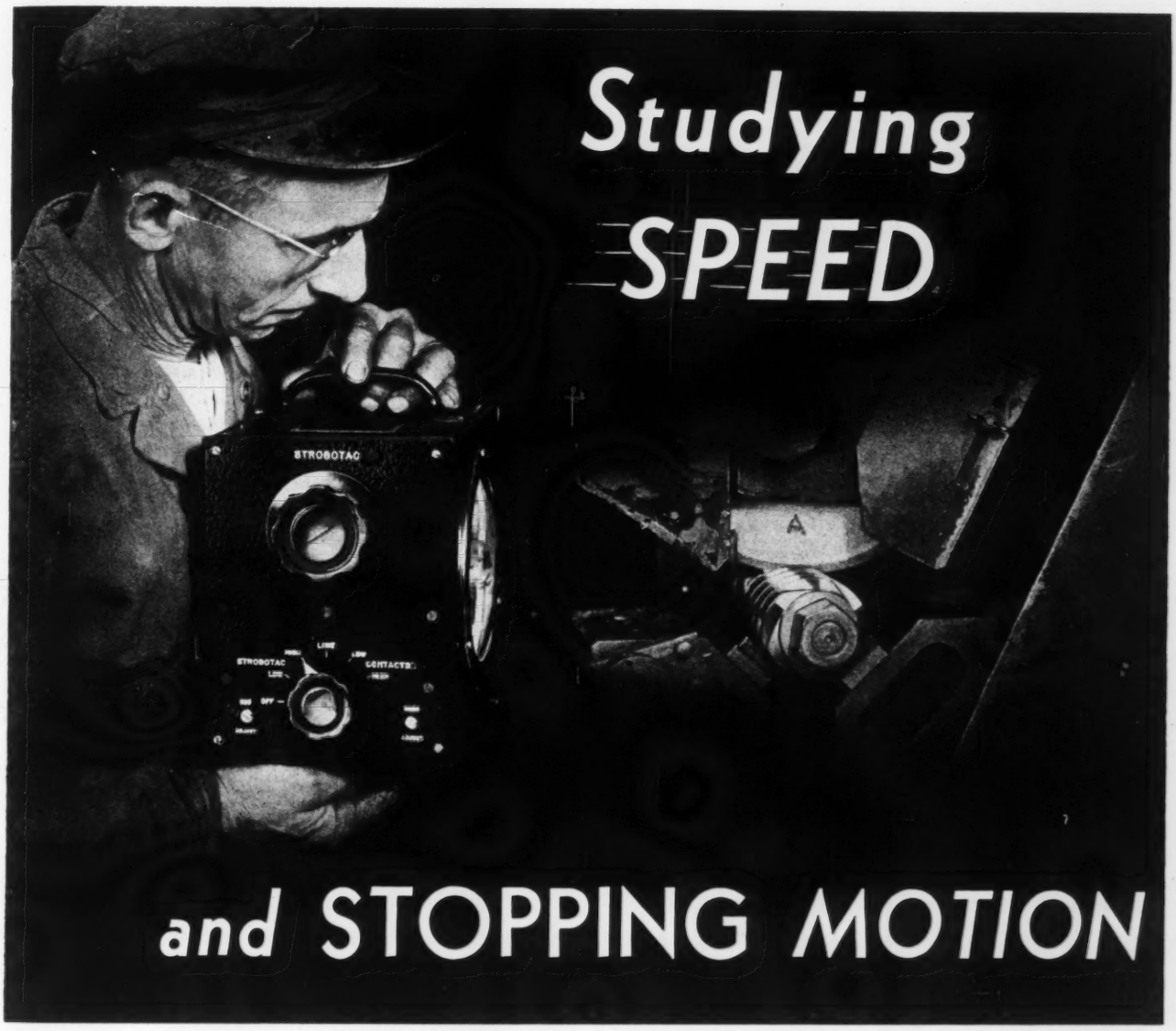
Relay Offers Broader Control

PUSHBUTTON locking relay control over a broader scope is offered by Guardian Electric Co., 1621 West Walnut street, Chicago, in its new S-120 On-Off ratchet relay. Simply designed, the relay has a special



Armature in relay rotates a four-point cam, making and breaking contact switches

armature rotating a four-point cam, making and breaking standard contact switches. Armature is full-float-



WITH THE NEW Type 631-B STROBOTAC the machinist in the photograph sees this high-speed helical gear grinder just as you see it . . . absolutely motionless . . . altho the wheel is *turning at 10,400 rpm!*

A slight adjustment of the speed control on the STROBOTAC and the *grinder is made to appear to turn at* any slow speed desired, even as slow as a fraction of an rpm, so that the exact cutting angle, cutting edge, shape of grind or any mechanical misadjustments of the grinder can be observed while the grinder is operating at full speed.

The STROBOTAC can help you as it has helped thousands of others to see IN SLOW MOTION the detailed operation of any rotating or reciprocating part in the most complicated machine. The STROBOTAC has proven invaluable to hundreds of designers, engineers, production men, maintenance men and salesmen. It can help you. Let us tell you how.

• *Write for Bulletin 458 for Information*

The Type 631-B STROBOTAC is the most recent model of the portable Stroboscope with many new features . . . illuminated speed control dial on top of the case . . . lighter and smaller case . . . single, conveniently operated control switch . . . direct-reading scale calibrated to 1% from 600 to 14,400 rpm. . . . speed and motion-stopping range of 600 to 100,000 rpm. . . . and still priced at only $95.00.

GENERAL RADIO COMPANY CAMBRIDGE MASSACHUSETTS

Perfect Control..

ALWAYS with

TRU·LAY

PUSH-PULL CONTROLS

● You can do away with the toggles, rods, bellcranks, pins, clevises and other parts that make control devices noisy and uncertain in operation. TRU-LAY Controls transfer motion directly and positively from stationary to moving points or mechanisms.

TRU-LAY Controls operate smoothly, silently and easily. They hold any position to which they are set. They relieve you of the constant adjustments and parts replacements required with other devices. Easily installed—because they are merely snaked around obstructions.

Write for the descriptive folder, "The Key to Remote Control."

AMERICAN CABLE DIVISION

12-252 General Motors Bldg., Detroit, Michigan

San Francisco: 630 Third Street

See our exhibit, Metals Building, New York World's Fair

TRADE MARK ACCO

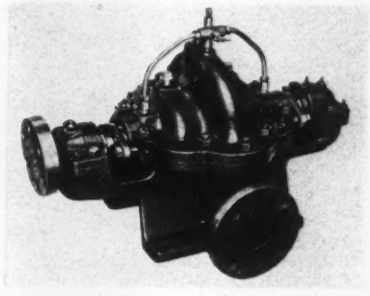
AMERICAN CHAIN & CABLE COMPANY, Inc.

In Business for Your Safety

ing type with readily accessible air-gap adjustment. All metal parts are heavily cadmium-plated. The coil requires 18 watts alternating current or 10 watts direct current to operate a single pole, double throw switch. Coils are furnished for operating on any alternating current to 220 volts, direct current to 110 volts. On-Off locking operating requires only a single circuit to the coil, the first impulse opening contacts, the next closing them.

Ball Bearings Now Standard on Pumps

INCLUSION of ball bearings as standard equipment on nearly all its line of centrifugal pumps where peripheral speeds are not excessive is announced by Allis-Chalmers Mfg. Co., Milwaukee. Sleeve bearings still may be specified if desired, however. A single row deep groove ball bearing on both ends of the pump is located in cast iron adapters arranged for grease lubrication. Designs call for conservative load-



Ball bearings have been included as standard equipment on line of centrifugal pumps

ings based on carefully computed thrust and radial loads. Locknuts at both ends of the shaft hold the bearings in place without resorting to any press or shrink fits. Use of an adapter inside the main housing provides a double seal which prevents grease from leaking to the exterior of the pump. At the same time any water which may enter the bearing housing is thrown off from the shaft before it can enter the adapter. When the pump is dismantled the adapters remain on the shaft as units to keep the bearings sealed and protected against damage.

Automatic Oilers Protect Parts

A NEW line of visible automatic constant level oilers with unbreakable reservoirs and adjustment oil level features, has just been announced by the Trico Fuse Mfg. Co., Milwaukee. The oiler illustrated automatically maintains the proper oil level in ring or ball bearings, gear and pump housings, etc., reducing maintenance expense, bearing failures, waste of oil or grease, and other dangers. One filling of the crystal-clear unbreakable reservoir is sufficient to lubricate a bearing three months or longer without attention. Reinforcing ribs of the reservoir give added strength, smooth appearance and a good grip when being handled. The reservoir is attached to the lower casting by the threaded spout and is easily removable

WHERE CAN I BUY THOSE GEARS?

Why, naturally, from any one of the 77 stock carrying distributors of Boston Gear products. In addition to gears, they carry stocks of speed reducers, chain and sprockets, and other power transmission accessories, all of which are described completely in the Boston Gear general catalog No. 52. Ask any one of the following for a copy of this catalog and seek their assistance when you have power transmission problems to solve.

CALIFORNIA, LOS ANGELES
Andrews Hardware & Metal Co.
Garrett Supply Company
CALIFORNIA, OAKLAND
C. W. Marwedel
CALIFORNIA, SAN FRANCISCO
C. W. Marwedel
COLORADO, DENVER
Denver Equipment Co.
Western Belting & Packing Co.
CONNECTICUT, BRIDGEPORT
Hawley Hardware Co.
CONNECTICUT, HARTFORD
Silliter-Holden, Inc.
CONNECTICUT, NEW BRITAIN
Smith & Klebes, Inc.
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C. S. Mersick & Co.
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J. M. Tull Metal & Supply Co.
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John D. Robinson Company
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Boston Gear Works, Inc.
Chicago Pulley & Shafting Co.
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ILLINOIS, ROCK ISLAND
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Vonnegut Hardware Company
INDIANA, SOUTH BEND
South Bend Supply Company
IOWA, DES MOINES
Standard Bearings Company
IOWA, SIOUX CITY
Standard Bearings Company
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Somers, Fitler & Todd Co.
PENNSYLVANIA, SCRANTON
Chas. B. Scott Company
PENNSYLVANIA, YORK
Geo. F. Motters Sons Supply Co.
RHODE ISLAND, PROVIDENCE
Machine Parts Corp.
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Chattanooga Belting & Sup. Co.
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W. J. Savage Co. Inc.
TENNESSEE, MEMPHIS
Lewis Supply Company
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Apex Machine Mfg. Co.
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Cragin & Company
WEST VIRGINIA, CHARLESTON
Baldwin Supply Company
WISCONSIN, MILWAUKEE
The Western Iron Stores Co.

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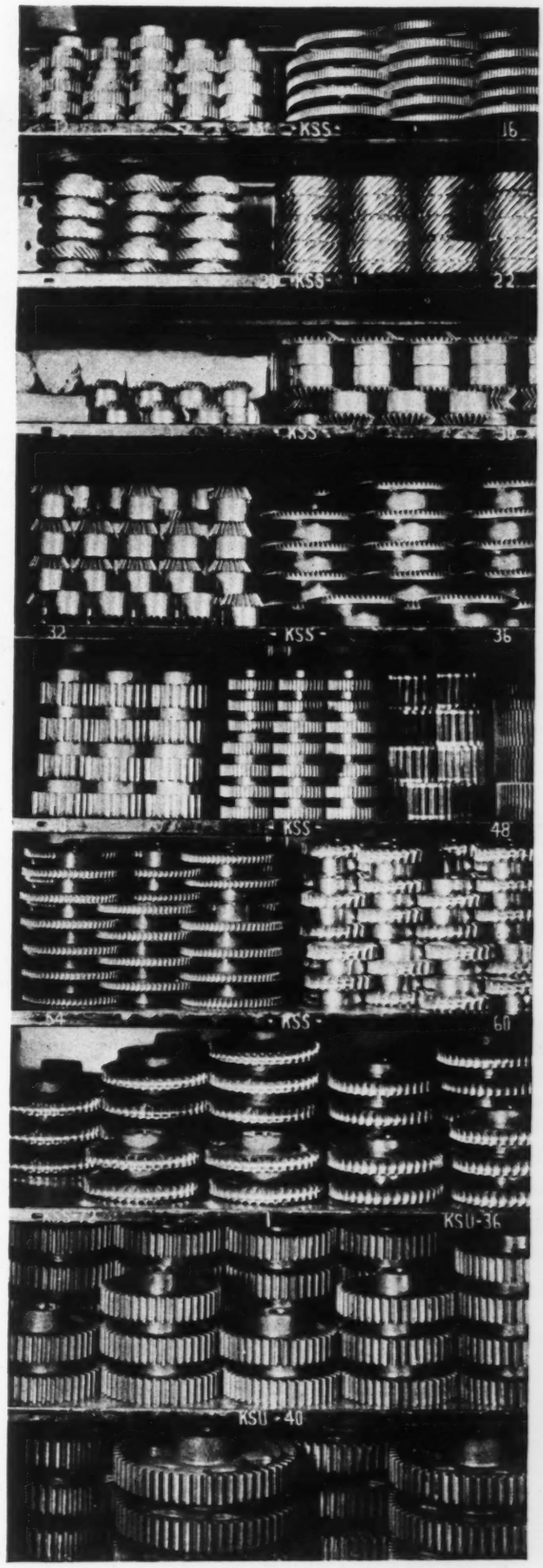


BOSTON GEARS

BOSTON GEAR WORKS, INC.
NORTH QUINCY, MASS.

Tell us when you need ACCURATE WIRE FORMS—

IN the Accurate plant there is a battery of modern Four Slide machines turning out wire forms at the rate of thousands per hour. Some of these wire shapes are odd — some are extremely simple — but most all of them have important jobs to do. That's why they must be carefully designed—accurately made—and also economically produced. They are at Accurate!

We invite you to TELL US when you need wire forms, springs, or small stampings. Ask for quotations or to see an Accurate engineer.

ACCURATE SPRING MFG. CO.
3813 W. Lake Street **Chicago, Ill.**

for cleaning and refilling. Capacities are one, two, four and eight ounces.

Circuit Breakers Made Smaller

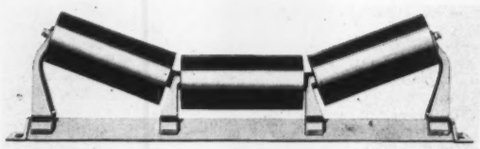
AN ADDITION to its line of Multi-breakers is announced by the Square D Co., Detroit. The new MO models, reduced in size and limited in capacity to 25 amperes, are available in single or double pole with

Additions to line of circuit breakers are reduced in size, limited to 25-ampere capacity

flush or surface mounting, with or without grounded or insulated neutrals. Capacities are 15, 20 or 25 amperes for 115-230-volt alternating-current service.

Idler Handles Medium Weights

CHAIN BELT CO., Milwaukee, has developed a ball-bearing idler, designated as type B-304, for handling materials of medium weight consisting of fines and small lumps. It is suitable for conveyor widths of 14 to 30 inches. The idler rolls are made from 4-inch diameter smooth finished steel tubing with formed heads pressed into and welded to each end. Heads are ball-bearing equipped with effective sealing against



Ball bearing idler for handling materials of medium weight is suitable for conveyor widths of 14 to 30 inches

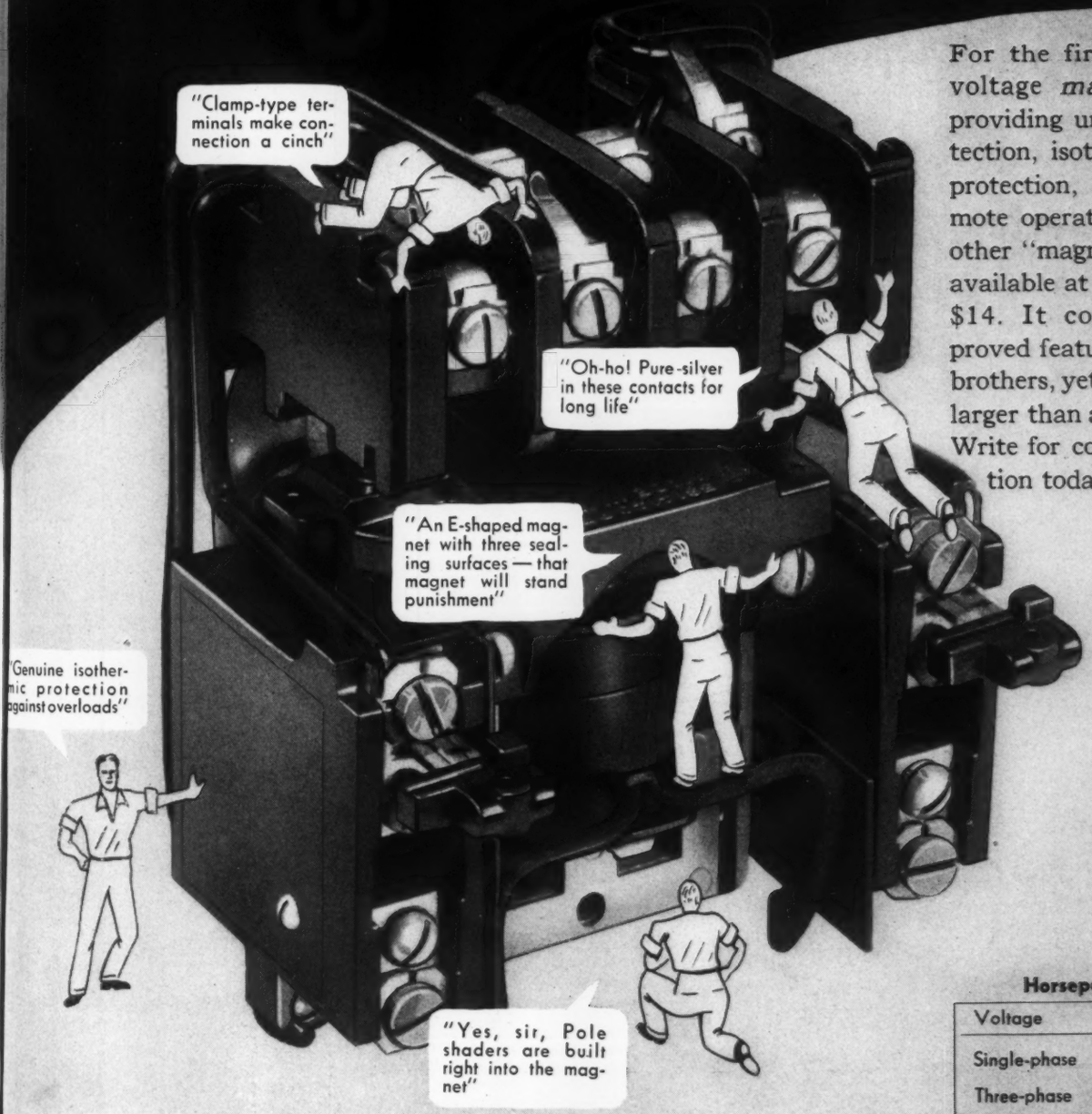
dust and dirt. The rolls are rounded and smooth to prevent injury to a conveyor belt and may be quickly removed. High pressure lubrication is provided for either or both ends of the idler by means of button-head grease fittings which are regularly furnished. The troughing idler rolls are supported in strongly ribbed brackets of unbreakable malleable iron construction, the brackets in turn being supported on an inverted angle base which is definitely self-cleaning.

Offer Small Aircraft Type Motor

THE type El-Y aircraft electric motor announced by the Dumore Co., Racine, Wis., weighs only three pounds. Spur type gearing is used in a rugged

INTRODUCING

NEW MAGNETIC STARTER FOR SMALL MOTORS


"Clamp-type terminals make connection a cinch"
"Oh-ho! Pure-silver in these contacts for long life"
"An E-shaped magnet with three sealing surfaces — that magnet will stand punishment"
"Genuine isothermic protection against overloads"
"Yes, sir, Pole shaders are built right into the magnet"

For the first time, a full-voltage *magnetic* starter providing undervoltage protection, isothermic overload protection, facilities for remote operation, and all the other "magnetic" features is available at the low price of $14. It contains all the proved features of its bigger brothers, yet it is only a little larger than a manual starter. Write for complete information today.

Horsepower Ratings

Voltage	110	220	440/600
Single-phase	1	1½	
Three-phase	1½	2	2

GENERAL ELECTRIC

080-194

HOW FLAMENOL

R... U. S. PAT. OFF.

Saves Space

ONE Covering Serves 2 Purposes

WHERE space on your product is at a premium, we recommend Flamenol wire. It may be the answer to that problem—as well as to others. Here's why it saves space.

Ordinarily, an insulated wire needs two coverings—one for insulation, the other for protection.

Flamenol combines the two: it has high dielectric strength—720 volts per mil; it has high tensile strength—2000 pounds per square inch. Thus, one covering serves two purposes. Compare size with other types of wire and see the difference.

DIELECTRIC STRENGTH
720

TENSILE STRENGTH
2000

For Wiring High-grade Equipment

But space saving is not the only advantage in wiring panels, printing presses, or machine tools with Flamenol. Others are: flame resistance—it will not support combustion; 12 colors—easy to trace circuits; unaffected by oils or mild acids; never has shown any signs of aging—will last for years.

For your product, Flamenol may be the answer to many a troublesome wiring problem. A G-E cable specialist will be glad to help you decide. Address the nearest G-E sales office, or General Electric, Dept. 6 - 201, Schenectady, N.Y.

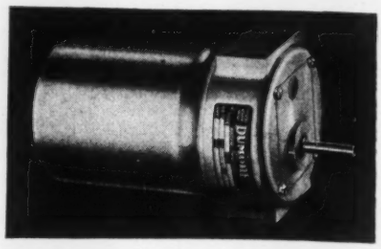
GENERAL ELECTRIC INSULATED CABLE — ALWAYS THE RIGHT TYPE FOR EACH JOB

Approved by Underwriters. For details see Bulletin GEA-2733C. Ask for a bag of Flamenol wire samples.

GENERAL ELECTRIC

520-176

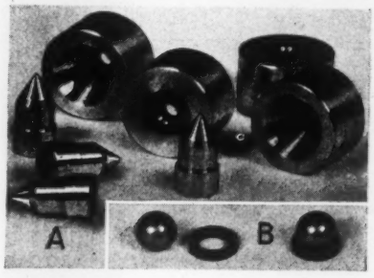
housing with all screws safety-wired to withstand vibration. Carbon brushes and commutator are large enough to handle heavy currents without undue heating. Horsepower range is 1/20 to 1/16; speed range, 200 to 1200 revolutions per minute.



Weighing only three pounds, small aircraft type motor uses spur type gearing in a rugged housing

Compound Used in Pump Valves

PUMP valves and other valves subject to unusual abrasive or corrosive action are now being successfully made of Kennametal, the new intermetallic compound of tungsten-titanium carbide manufactured by McKenna Metals Co., 146 Lloyd avenue, Latrobe, Pa. Several high pressure needle valves equipped with Kennametal needle tip and seat are shown at A in the illustration. Oil well pump valves with Kennametal balls and seats are illustrated at B. Kennametal can be supplied in any desired shape for valve parts and in three grades having varying physical properties.



Valves subject to unusual abrasive or corrosive action are now being made of intermetallic compound

Photoelectric Relays Developed

PHOTOSWITCH control relays made by Photoswitch Inc., 21 Chestnut street, Cambridge, Mass., provide photoelectric combinations suitable for industrial control. Circuits may be closed either by the presence or absence of light. Housings are dust-proof,

Circuits of electronic relays may be completed by presence or absence of light

Exterior 500 M. P. H. Tunnel

8000 H.P. TORNADOES

ON SKF BEARINGS

AT LANGLEY FIELD

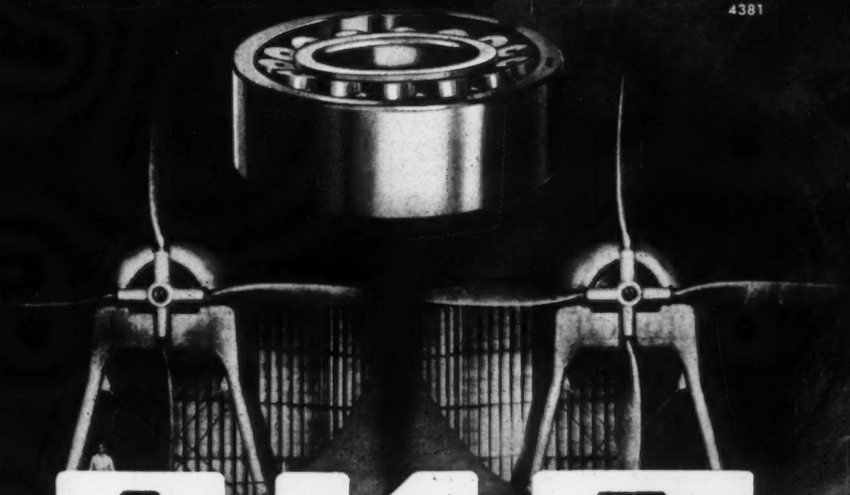
HOME OF THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

Tunnel Type	Motor H.P.	Motor Make	SKF Locations
500 M.P.H.	8000	Crocker-Wheeler	at fan
19-Ft. Pressure	8000	Crocker-Wheeler	motor
Full-Scale	two 4000	General Electric	motors

THERE'S something in the wind of the new tunnels at Langley Field. There are tornado velocities up to 500 miles per hour produced by giant 8000 H.P. motors on SKF Bearings.

The satisfactory performance since 1931 of SKF Spherical Roller Bearings on the Full-Scale Tunnel and on other smaller tunnels led to their use on the newly constructed 500-Mile-Per-Hour and 19-Foot Pressure Tunnels. Just another illustration of the important role that SKF is playing in developing the aircraft of tomorrow. SKF Industries, Inc., Philadelphia, Pa.

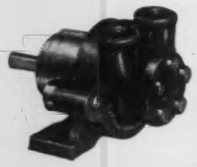
4381



ROLLER SKF BEARINGS

Interior Full-Scale Tunnel

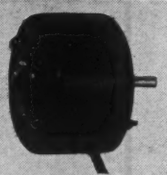
GOING PLACES—AT LOW COST



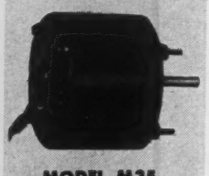
Machine designers are getting results in cutting power costs with Tuthill Small Pumps. Power requirements are today the lowest in Tuthill history . . . another reason to specify this dependable, mechanically sealed pumping equipment. Capacities from 1/3 to 3 g. p. m. Pressures up to 400 lbs. per sq. in. Wide variety of mountings. Write for Small Pump Catalog today.

TUTHILL PUMP COMPANY
941 EAST 95TH STREET, CHICAGO, ILLINOIS

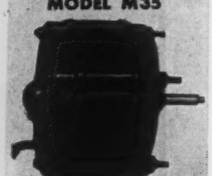
VICTOR
Super-Power
MOTORS



MODEL M41



MODEL M35



MODEL M6

SHADED POLE . . .
. . . Induction Type

Victor offers an outstanding line of quality-built motors of fractional power ranging from 1/200 to 1/10 H. P. Ideal for such applications as fans, blowers, animated displays, timing devices, etc. Years of successful motor building — equipped to solve difficult engineering problems. Write for literature today!

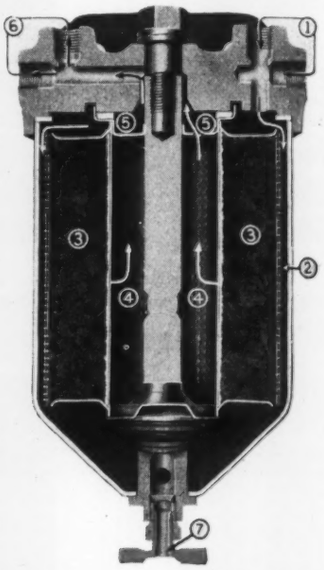
Manufacturers' Representatives:
A few territories not yet assigned. If interested, write us at once.

VICTOR ELECTRIC PRODUCTS, INC.
3036 Robertson Avenue Cincinnati, Ohio

water-proof, built to withstand rough handling. A complete photoelectric counter in one housing may be specified. Current consumption is 30 watts.

Filter for Machine Tools

FOR the protection of bearings used on grinders, automatic screw machines and other machine tools, a new oil filter has been developed by the AC Spark Plug division of General Motors Corp., Flint, Mich. Known as type T-1, the filter is easily installed.

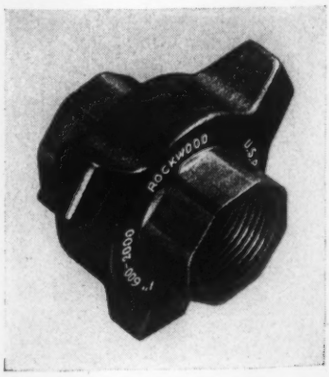


Oil filter for protecting bearings on machine tools removes all solid impurities from the oil

It removes all solid impurities such as fine metal chips, from the oil, thereby protecting bearings and enabling the machine to do better work, particularly from a precision standpoint.

Pipe Unions Utilize Triple Lug Nut

DUALSTEEL alloy hammer lug unions with a triple lug nut have been introduced by Rockwood Sprinkler Co., 38 Harlow street, Worcester, Mass. One lug is always in position where it can be easily struck by a hammer. This union is particularly suitable for



Hammer lug unions with triple lug nut are particularly suitable for machines having process pipe lines

machines having process pipe lines where unions are needed which can be made up and broken apart frequently. The corrosion-resistant steel in the unions

What Users Say about this NEW-TYPE QUILL BEARING

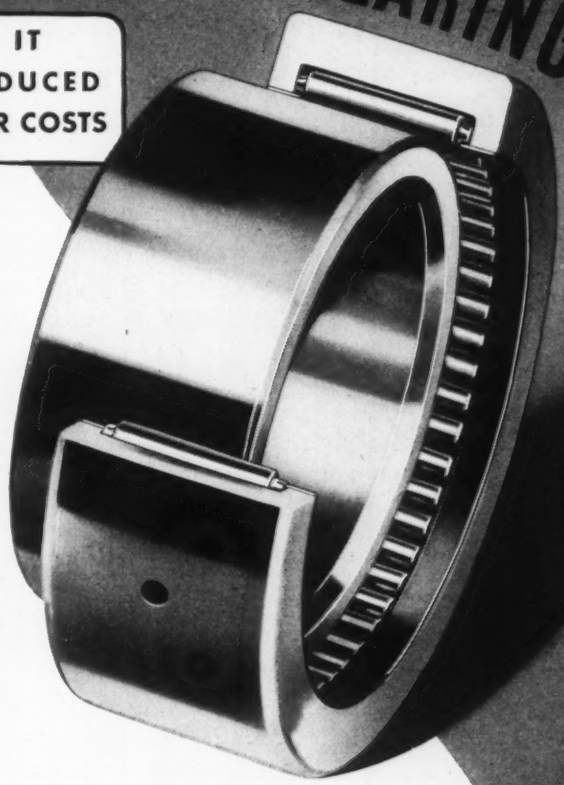
IT REDUCED OUR COSTS

IT CARRIES HEAVIER LOADS

IT TAKES LESS SPACE

IT'S EASIER TO ASSEMBLE

IT'S FAR MORE DEPENDABLE



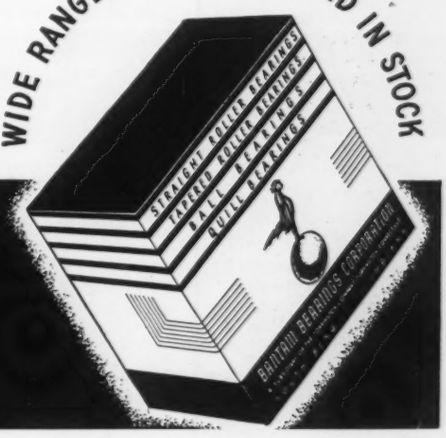
BANTAM'S new-type Standard Series Quill Bearings have scored a phenomenal *sales success* based solely on *operating success*. In a wide range of industries they have proved their ability to solve bearing problems of long standing. Repeat orders prove the satisfaction of users who write us enthusiastically about savings in cost and improvements in performance.

This new type Quill Bearing is built to the same high quality standards as the Bantam Quill Bearings used on Diesel-powered streamline trains. The design is greatly simplified. There are no fragile parts—no possibility of failure. New method of roller retainment provides for quick, easy assembly. End thrust is taken on the ribs of the one-piece channel-shaped outer race. Correctly proportioned rollers with husky curvilinear trunnions insure longer service.

For complete engineering data, write us for Bulletin 103B. For Needle Bearings to be used in lighter service write our affiliate, The Torrington Company, Torrington, Conn., and ask for Circular 21A.

BANTAM BEARINGS CORPORATION
South Bend, Indiana
Subsidiary of THE TORRINGTON CO.
Torrington, Conn.

WIDE RANGE OF SIZES CARRIED IN STOCK



TAPERED ROLLER—STRAIGHT ROLLER—BALL

BANTAM BEARINGS

HYDRON
Metallic Bellows

HYDRON Metallic Bellows are used as control elements in temperature-and-pressure-control devices, and for liquid or gas seals of compressors and pumps. We are specialists in the design and production of complete thermostatic and pressure units for temperature and pressure controls. We are, therefore, prepared to extend the fullest co-operation to engineering departments of control manufacturers in the solution of design and engineering problems.

Write for 44 PAGE ENGINEERS' DATA BOOK

CLIFFORD MANUFACTURING CO.
564 E. FIRST STREET, BOSTON
BOSTON CHICAGO DETROIT LOS ANGELES
PRODUCERS OF BELLOWS EXCLUSIVELY
SERVING AUTOMATIC CONTROL MANUFACTURERS

When You Select Gasoline Motors for Your Equipment, Get the World's Finest!

Briggs & Stratton 4-cycle, air-cooled motors set the standard, the world over, by which gasoline motor performance is judged . . . Full range of models for every application requiring from ½ to 5 HP

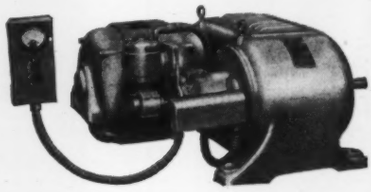
It's Powered RIGHT when it's Powered by
4 CYCLE BRIGGS & STRATTON GASOLINE MOTORS

Also Builders of INDUSTRIAL VARIABLE SPEED TRANSMISSIONS — AUTOMOTIVE EQUIPMENT — AUTOMATIC AIR-SAVERS

has an ultimate strength of 85,000 pounds per square inch and a yield point of 55,000 pounds. Brinell hardness is 190 to 200.

Remote Speed Indicator Announced

PROVIDING an accurate, simple means of selecting the operating speed from a remote point, an electric remote speed indicator has been developed by U. S. Electrical Motors Inc., Los Angeles, for use with the U. S. Varidrive motor. The device consists of a simply

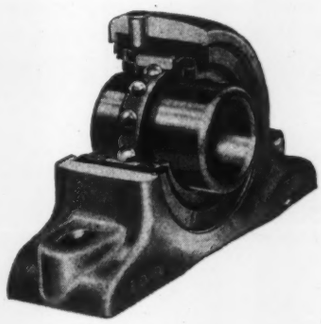


For use with Varidrive motor, electric speed indicator has been developed for remote control of speed

constructed meter as an indicator mounted in a compact box with the pushbutton for controlling the electric pilot motor that changes the speed. The indicator is neatly calibrated in divisions from 1 to 10, although other scales may be specially calibrated.

Noiseless Pillow Blocks Offered

OFFERING noiseless antifriction efficiency on many applications where the cost of ball bearings has hitherto been prohibitive, Ahlberg Bearing Co., 3025 West Forty-seventh street, Chicago, has developed



Series of pillow blocks for light duty has been developed for applications where quiet operation is desirable and necessary

the new series ED-R pillow blocks. Designed for light duty, these units may be utilized in domestic airconditioning units, attic fans, etc., where quiet operation is desirable. The precision CJB bearing is completely insulated from the metal housing by a molded cushion of neoprene. Seals are of floating construction which eliminates friction and gives both seals and bearings longer life. Housings are die-cast. Shaft sizes are ½, ⅝, ¾, 15/16 and 1-inch.

Weld Powder Deposited in Thin Layer

SURFACEWELD A, a fine grained alloyed powder to be applied with the carbon arc, has been announced by the Lincoln Electric Co., Cleveland. It gives a smooth, dense, hard surface and can be applied in a very thin layer if desired. Properly applied, it

SHAFER

self-alignment not only permits simple and compact bearing applications, with resulting economies, but provides inherent compensation for shaft deflection, misalignment, and shock. Shafer capacity for heavy duty service is the result of the exclusive CONCAVE roller design; combining: 1. Integral self-alignment; 2. Capacity for radial, thrust, or combined radial-thrust loads; 3. Simple adjustability.

Available in a full range of sizes: Pillow Blocks • Welded Steel Pillow Blocks • Flange Units • Take-up Units • Cartridge Units • Hanger Boxes • Flange-Cartridge Units • Duplex Units • Conveyor Rolls • Radial-thrust Roller Bearings

SHAFER BEARING CORPORATION
35 East Wacker Drive — Chicago

CONCAVEX

SHAFER *Self-Aligning*
ROLLER BEARINGS

BARCO

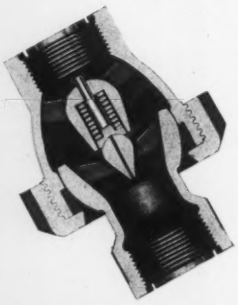
CENTER SPRING—STREAMLINED

FLEXIBLE BALL JOINTS

Stainless steel spring shrouded for protection against fluids, corrosion and erosion.

Spring pressure against ball in exact center, providing equal pressure of ball against gasket seat in all positions with minimum friction.

Automatic adjustment.



Catalog 320 will give you the complete details

Barco Manufacturing Co.
1820 Winnemac Avenue
CHICAGO, ILL.
In Canada: The Holden Co., Ltd.

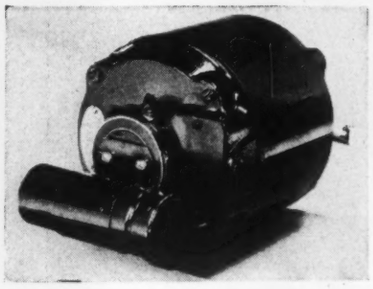
D.O.JAMES
FLEXIBLE
COUPLING
Compensates the misalignment. Simple construction. Mechanically Flexible. Easy to line up. Noiseless. No back lash. Self-lubricating. Creates no end thrust within itself.
STOCKED FOR IMMEDIATE SHIPMENT

SEND FOR ILLUSTRATED COUPLING FOLDER
OVER FIFTY YEARS MAKERS OF ALL TYPES OF SPEED REDUCERS AND CUT GEARS
D. O. JAMES MANUFACTURING CO.
ESTABLISHED 1888
1120 WEST MONROE STREET CHICAGO, ILLINOIS

gives a coating with a hardness of approximately Rockwell 54C. Full hardness is developed in the as-deposited condition, and softness will not result from annealing. Applied in very thin and smooth layers, its limit of thinness is governed from a practical standpoint when the deposit becomes so diluted with the base metal that the Surfaceweld A will not flow properly. A deposit as thin as .025-inch can be applied to light metal such as 12 to 20 gage.

Motor for Light Duty Developed

A NEW motor announced by Westinghouse Electric & Mfg. Co., East Pittsburgh, for unit heater, fan and blower applications, provides single speed operation with the ordinary on and off switch for either 110 or 220-volt circuits; high and low speeds with an inexpensive two-speed switch; and multispeed operation with a speed controller with either voltage.



Motor for unit heater, fan and blower applications provides either single, two-speed or multispeed operation

It comes in 1/20 to ¾-horsepower sizes. Special sleeve bearings absorb shocks imposed by propeller fans, and large oil reservoir packed with yarn insures adequate lubrication. Oversize shaft between bearings reduces bearing wear and vibration and maintains a constant air gap. A ventilated rotor gives cooler running and annealed laminations reduce power losses.

Engineering Dept. Equipment

Lightweight Drafter Announced

A STURDY, fast, low-priced drafting machine is announced by Eugene Dietzgen Co., Chicago, under the name Reliance. It is intended to bring the advantages of drafting-by-machine to boards where volume or type of work does not justify investment in larger units. Light weight with strong anchor construction, the Reliance's protractor and knob are built in one integral unit, the protractor turning through a full 360 degrees. A new adjustment feature compensates for natural wear and increases useful life. Easy thumb control of the protractor is provided through a new angle lock. Scale chuck plates take any standard scales. The machine is for drawings up to 23 x 28 inches.

So that Mice *may be* Beautiful

Cuno *continuously-cleanable* filters are screening out dried particles and skins from paint that's sprayed on everything from toy mice to Cadillacs. Gun nozzles used to clog. Paint jobs used to look sick. But not any more. Cuno is on the job, continuously and *more economically*.

WE MAKE BALANCE SHEETS BEAUTIFUL, TOO

No matter what your fluid is — nor how much of it there is — Cuno can strain it. Continuous protection. No duplex installations. No shutdowns for cleaning. The Cuno cleans itself: small ones with a flick of your wrist, big ones with a motor. The losses that used to pile up from old fashioned stop and go straining are gone.

OF INTEREST TO DESIGN ENGINEERS

"80 Ways to Make More Money" is a book that tells about actual case histories in *your* industry, as well as the Cuno principle of *edge* filtration. Write for it today, using the coupon below. It's free to you.

Cuno Engineering Corporation
268 South Vine Street
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Please send me, free, "80 Ways to Make More Money."

Name.....

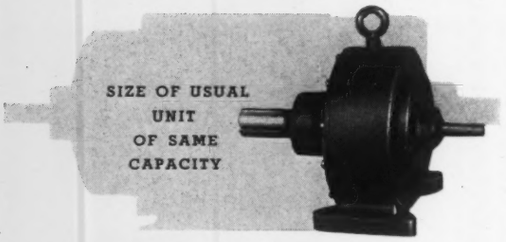
Company..... City..... State.....

Street.....

avoid stop and go with CUNO *Filters*

CUNO ENGINEERING CORPORATION ★ MERIDEN, CONNECTICUT

Nearly TWICE AS COMPACT as Units of Like Capacity



WHS *Differential*

SPEED REDUCER

Unlimited ratio . . . . 20 to 1 or 20 million to 1, in any one housing. Efficiency, 90 to 95%. Range and compactness never before available in any speed reducer. More teeth in action and stronger teeth for a given pitch.

Quiet-running helical gears of best heat-treated alloy steel. *Timken bearings* on high and low speed shafts. Get our low prices! *Send for catalog.*

WINFIELD H. SMITH, Inc.

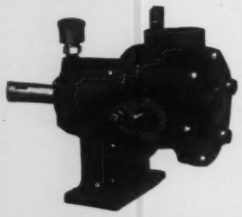
A Speed Reducer for Every Application

16 ELTON STREET, SPRINGVILLE, ERIE COUNTY, N.Y.

TAKE A PERMANENT VACATION

FROM PUMPING WORRIES

If you're just about a nervous-wreck from fighting stubborn pumps all day—install Viking and take a lasting vacation from pump worries. Do a little investigating and you'll find that leading Machine Tool manufacturers from coast to coast specify Viking Coolant Pumps. Write for a copy of Bulletin 1100-32 . . . note the complete selection offered in models, mounting and capacities.



VIKING PUMP CO.
CEDAR FALLS, IOWA.

How Smooth Is Smooth?

(*Concluded from Page* 31)

mond or a hard metal tool, finish grinding, and honing, with a roughness factor S varying from 8 to 32 microinches.

The proposed standard gives 14 classes, with maximum S values chosen from the American Standard preferred numbers. These values are listed below, in order of increasing smoothness.

63*M*, 16*M*, 4*M*, 1*M*, 250, 63, 32, 16, 8, 4, 2, 1, ½, ¼.

The symbol *M*, which stands for 1000, is used to shorten the symbols designating the four roughest surfaces, because the symbols are to be inserted in a V-shaped mark to indicate surface roughness on drawings, as shown in *Fig.* 8.

Additional classes may sometimes be required. For example, there may be a need of finer subdivision of the total range. In such cases, selection of an S value from the following additional series is recommended:

500, 400, 320, 200, 160, 130, 100, 80,
50, 40, 25, 20, 13, 10, 6, 5, 3, 2½, 1½.

These values also belong to the series of preferred numbers, but should be used only if no value from the first series (63M to ¼) is satisfactory.

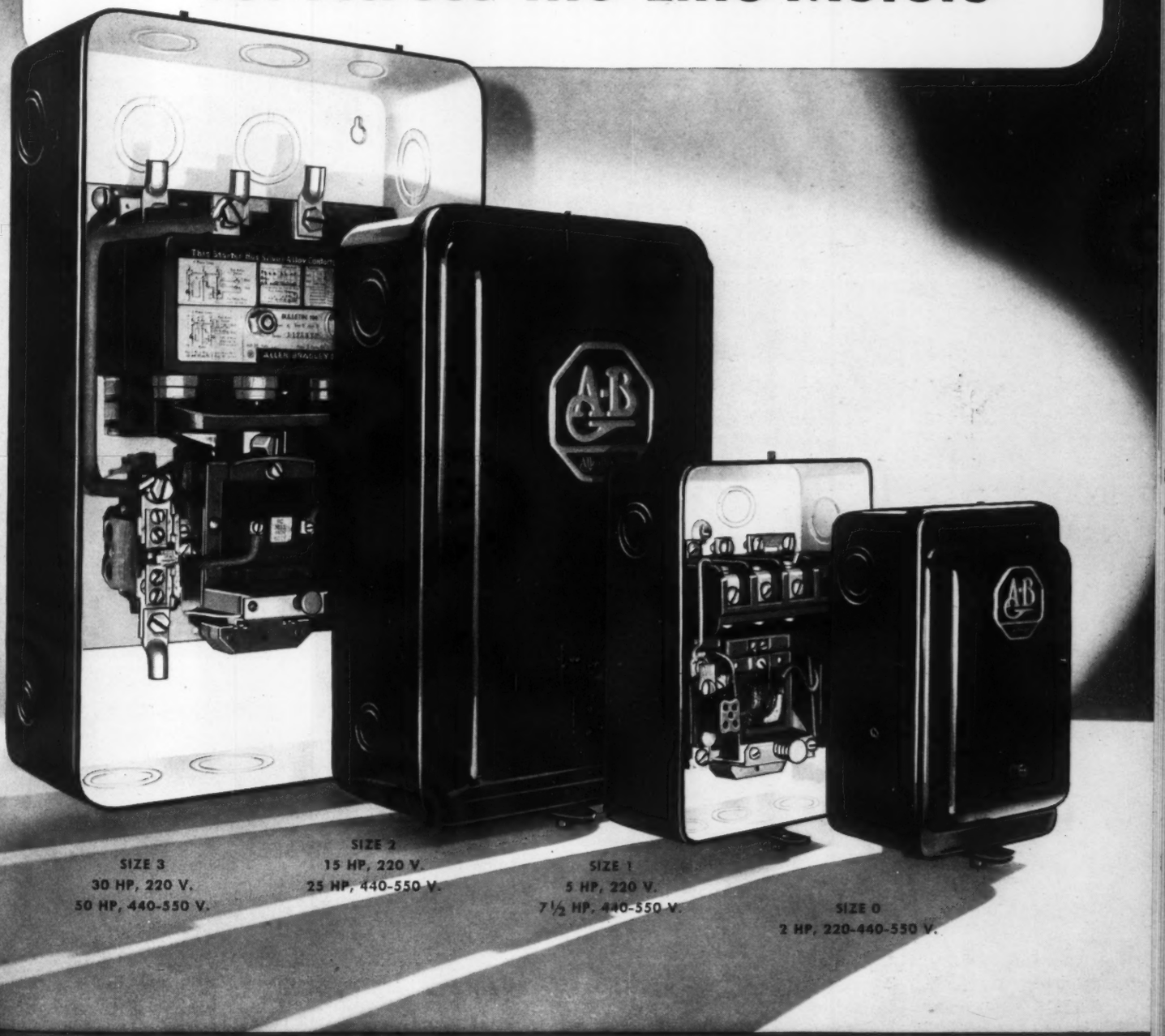
Use of Roughness Factors

The designer may find it necessary to specify not only a maximum permissible roughness, but also a minimum, see *Fig.* 8. Specification of two limits may be desirable even though any surface smoother than required is acceptable. The reason is higher surface quality generally means increased cost. Therefore, the designer should specify a surface roughness of no higher class than required. Yet, if only a maximum S value is given, the shop may produce—and the inspector will have to accept—a surface with a quality that is better, but also more expensive, than the one specified on the drawing. This will be prevented by the addition of a minimum permissible S value on the drawing.

The designer, then, must choose between two methods of specifying surface roughness. One is to give the maximum S value only, leaving the shop or the outside supplier freedom to produce a higher quality finish. The other method is to use two limits in which case the designer should keep these limits as widely apart as is compatible with required performance and appearance of the surface on the one hand, and cost of production on the other.

Which one of the two methods should be used is a question to be answered by the designer in each individual case. In general, it will be sufficient to specify only a maximum value, because usually the producer of the surface will not unnecessarily supply a surface with a quality higher than specified by the designer.

A Popular Family of Solenoid Starters for Across-the-Line Motors



SIZE 3
30 HP, 220 V.
50 HP, 440-550 V.

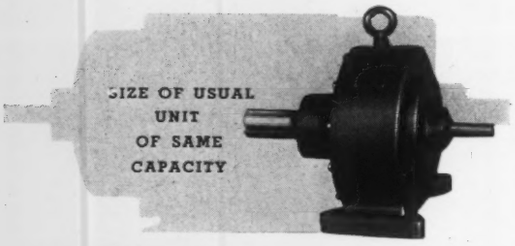
SIZE 2
15 HP, 220 V.
25 HP, 440-550 V.

SIZE 1
5 HP, 220 V.
7½ HP, 440-550 V.

SIZE 0
2 HP, 220-440-550 V.

ALLEN-BRADLEY
SOLENOID MOTOR CONTROL
QUALITY

Nearly TWICE AS COMPACT as Units of Like Capacity



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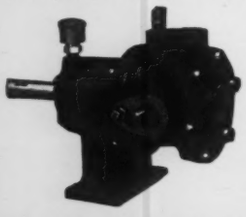

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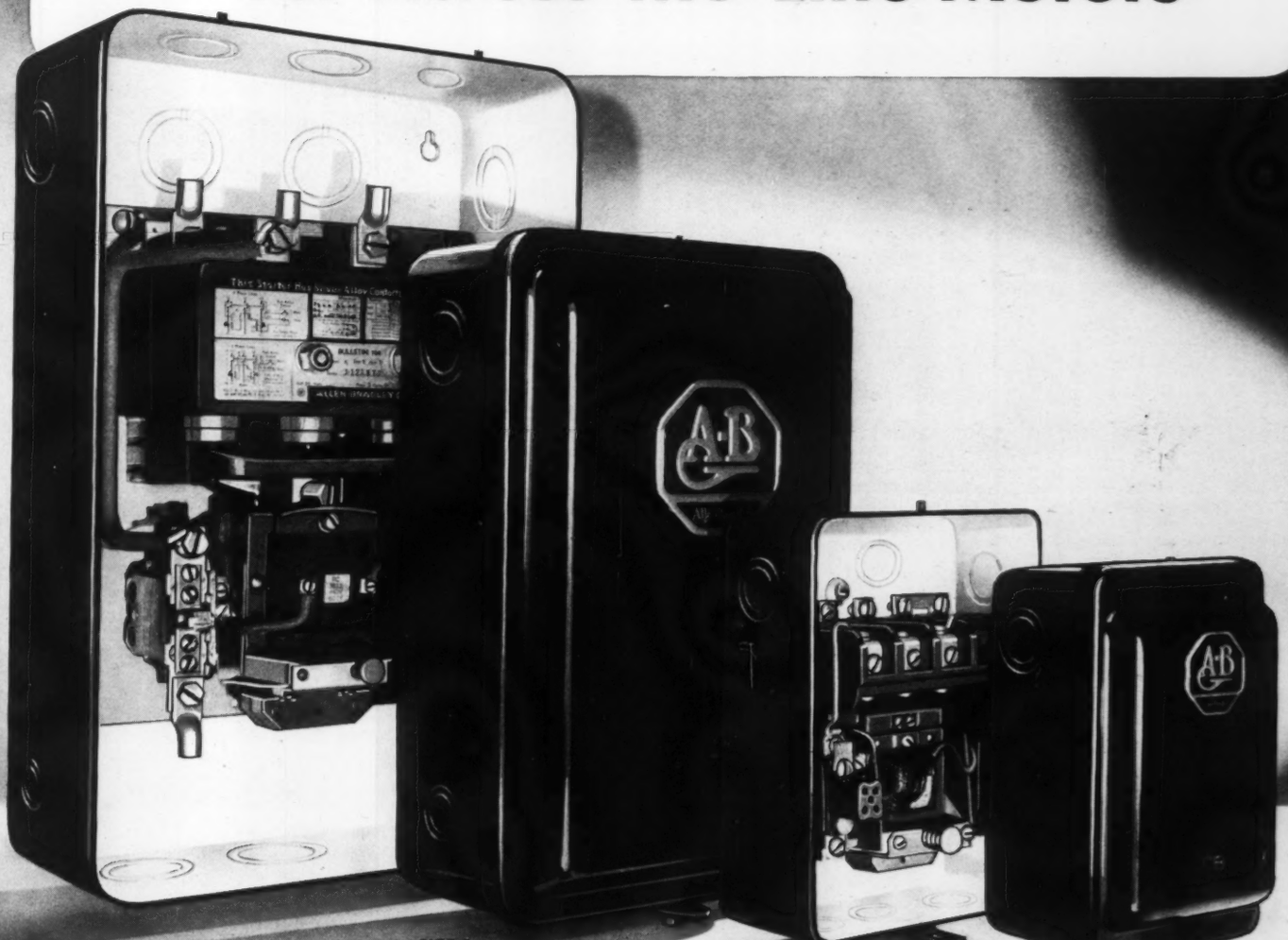
The designer may find it necessary to specify not only a maximum permissible roughness, but also a minimum, see *Fig.* 8. Specification of two limits may be desirable even though any surface smoother than required is acceptable. The reason is higher surface quality generally means increased cost. Therefore, the designer should specify a surface roughness of no higher class than required. Yet, if only a maximum S value is given, the shop may produce—and the inspector will have to accept—a surface with a quality that is better, but also more expensive, than the one specified on the drawing. This will be prevented by the addition of a minimum permissible S value on the drawing.

The designer, then, must choose between two methods of specifying surface roughness. One is to give the maximum S value only, leaving the shop or the outside supplier freedom to produce a higher quality finish. The other method is to use two limits in which case the designer should keep these limits as widely apart as is compatible with required performance and appearance of the surface on the one hand, and cost of production on the other.

Which one of the two methods should be used is a question to be answered by the designer in each individual case. In general, it will be sufficient to specify only a maximum value, because usually the producer of the surface will not unnecessarily supply a surface with a quality higher than specified by the designer.

A Popular Family of Solenoid Starters for Across-the-Line Motors



SIZE 3
30 HP, 220 V.
50 HP, 440-550 V.

SIZE 2
15 HP, 220 V.
25 HP, 440-550 V.

SIZE 1
5 HP, 220 V.
7½ HP, 440-550 V.

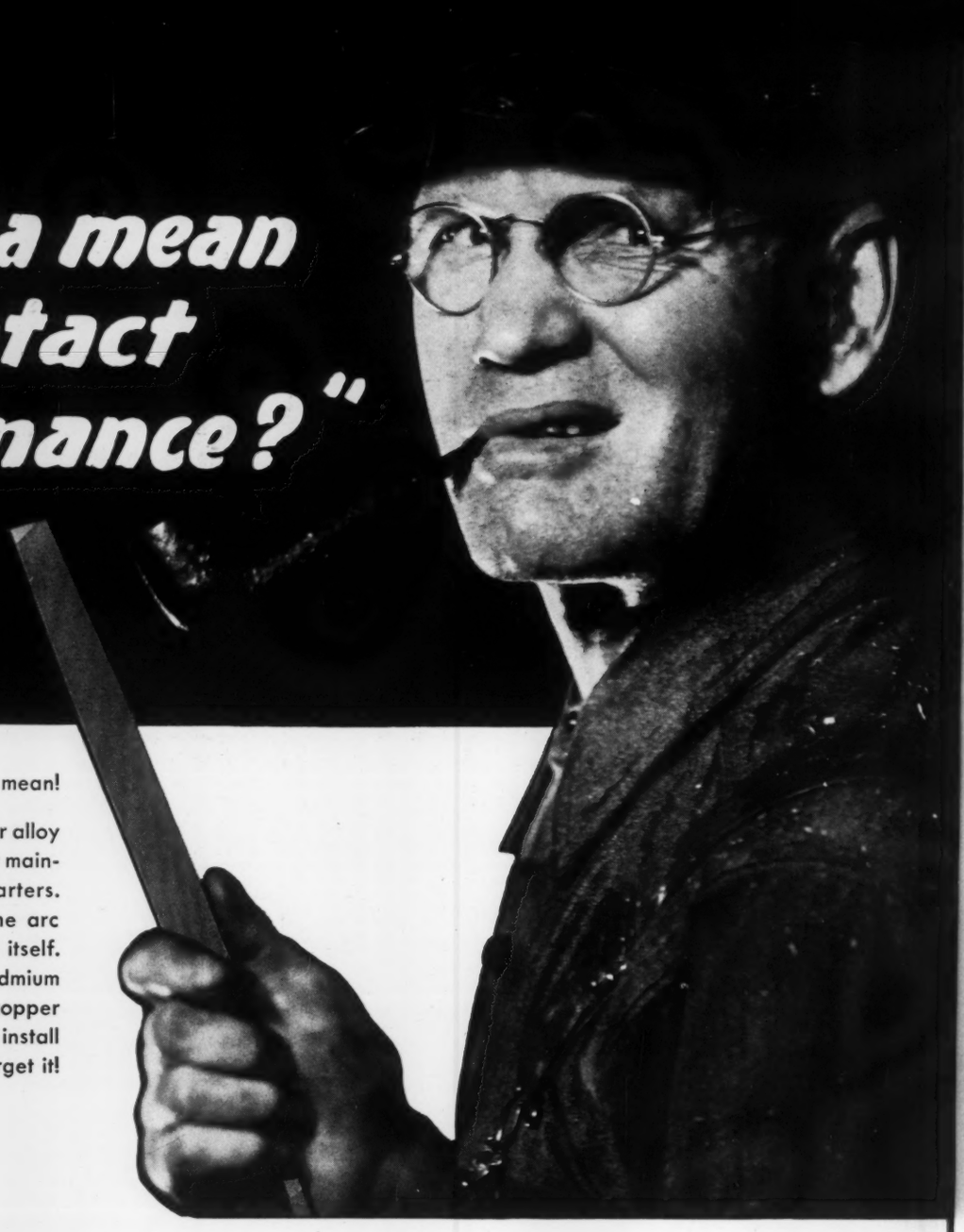
SIZE 0
2 HP, 220-440-550 V.

ALLEN-BRADLEY

SOLENOID MOTOR CONTROL

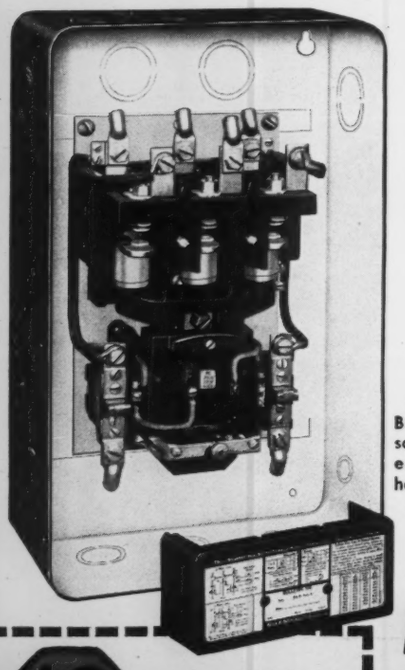
QUALITY

"What d'ya mean -no contact maintenance?"



Yes, siree! . . . that's exactly what we mean!

Don't you touch those Allen-Bradley silver alloy contacts with that file. There's no contact maintenance on Allen-Bradley solenoid starters. Why? Because any oxide formed by the arc is as good a conductor as the contact itself. You don't need to clean or file these cadmium silver contacts . . . like you do the old copper contacts. Here's our advice . . . after you install an Allen-Bradley solenoid starter . . . forget it!



Bulletin 709 solenoid starter with arc-hood cover off.

Five Other Advantages of the A-B Solenoid Starter

- **Simple Construction**
  There are fewer moving and wearing parts, assuring trouble-free operation. No bearings or pivots to gum up and corrode. No flexible jumpers to break and cause trouble.
- **Long Life**
  The sturdy rugged construction of all parts assures long life. Millions of operations are built into Allen-Bradley solenoid starters.
- **High Switching Capacity**
  These starters will easily disrupt currents of not less than ten times their maximum horsepower rating—will handle all load conditions.
- **Easy Installation**
  Ample wiring space, accessible terminals, white interiors, and knockouts on all sides and back of cabinet, make wiring easy.
- **Complete Line**
  Available in four standard sizes with a maximum rating of 30 hp, 220 v; 50 hp, 440-550 v. Enclosing cabinets are available for every industrial service condition.

Send for "The Story of the Solenoid Starter"

A-B

Allen-Bradley Co.
1333 S. First Street
Milwaukee, Wisconsin

Please send me a copy of "The Story of the Solenoid Starter."

NAME _____

COMPANY _____

STREET _____

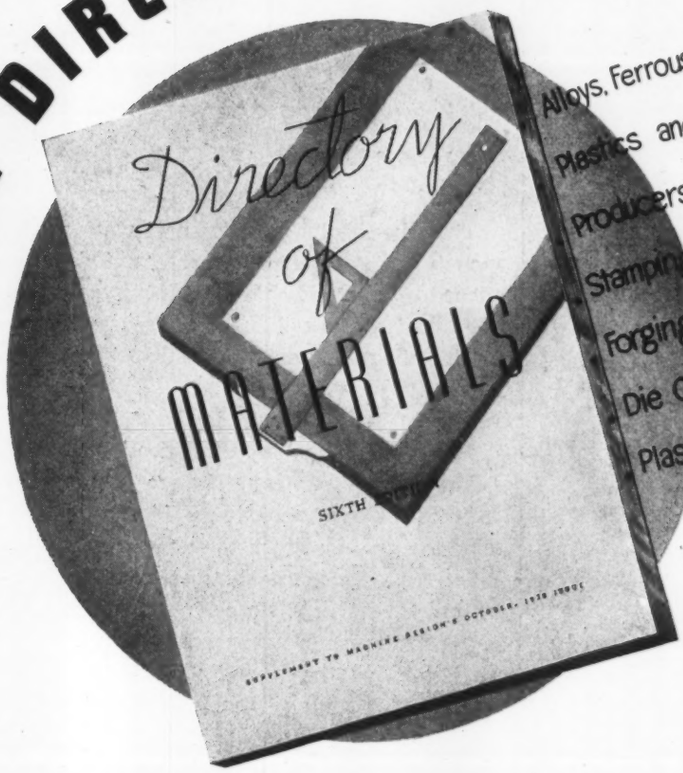
CITY _____ STATE _____

ALLEN-BRADLEY

SOLENOID MOTOR CONTROL

QUALITY

THE DIRECTORY OF MATERIALS....



- Alloys, Ferrous and Nonferrous, by Tradenames
- Plastics and Nonmetallic Materials, by Tradenames
- Producers of Tradenamed Materials.
- Stampings Producers
- Forgings Producers
- Die Castings Manufacturers
- Plastics Molders

MACHINE DESIGN's Annual Supplement

.... *for* DESIGN EXECUTIVES, CHIEF ENGINEERS and DESIGNERS

Recognizing the importance of correct materials selection, MACHINE DESIGN has published for a number of years an annual Directory of Materials, devoted exclusively to materials of machinery design.

The Directory, accompanying the coming October issue of MACHINE DESIGN, will be the Seventh Edition. It will contain seven separate and distinct lists of materials, including: 1: Alloys, Ferrous and Nonferrous, by Tradenames . . . 2: Plastics and Nonmetallic Materials, by Tradenames . . . 3: Producers of Tradenamed Materials . . . 4: Stampings Producers . . . 5: Forgings Producers . . . 6: Die Castings Manufacturers . . . 7: Plastics Molders.

Nowhere else can design executives, chief engineers and designers secure as complete and conveniently arranged lists of materials. Each listing contains a keyed description of the material . . . thus saving considerable time in checking up on possible applications.

Removable and filable, this Directory of Materials lends itself to filing for instant accessibility and convenient reference.

Extra copies of the Directory will be available. The supply will be limited however. For additional copies we suggest immediate reservations . . . twenty-five cents per copy, postpaid.

MACHINE DESIGN

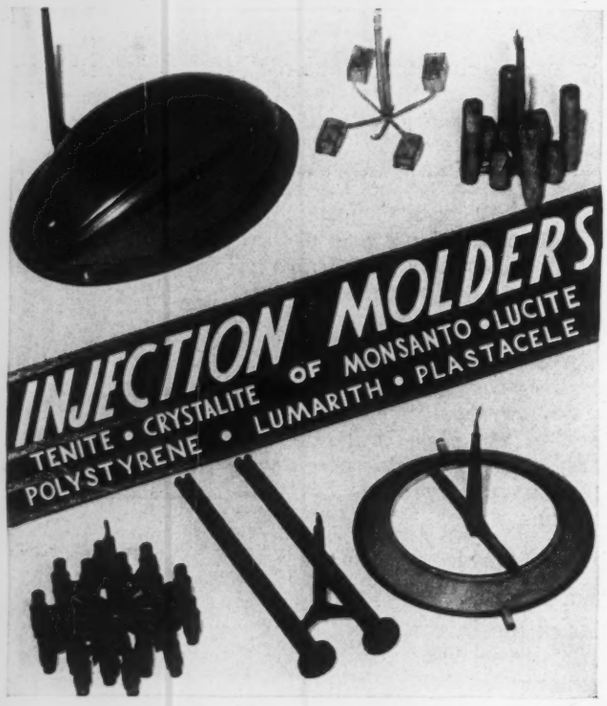
PARTS . . . MATERIALS . . . METHODS . . . FINISHES

Low Cost made possible by improved designs, large quantity production and production methods . . . Dependability developed thru hundreds of different applications in the field . . . Stamina built-in for continuous operation and . . . . . High torque developed thru integral back gearing . . . . Cased or skeleton types with standard gears that give "any" speed, that save engineering, cost, and space of requirements of auxiliary speed reducing means . . . . Single drives, double drives—from top, bottom, right or left. Miniature motors for a hundred uses; motors that make *automatic* tuning, *automatic* opening and closing, automatic features that make sales at incidental costs.

Sold singly, in dozens, thousands or millions.

SPEEDWAY MFG. CO.
1858 S. 52nd Ave.
Cicero, Ill., U. S. A.

WRITE for SPECIFICATIONS and PRICES



CHICAGO MOLDED PRODUCTS
Corporation
1028 No. Kolmar Ave. Chicago, Illinois

Spring Selection

(*Concluded from Page 38*)

G = modulus of rigidity, this equation may be written

$$\delta_1 = \frac{\pi}{4}\,\frac{P r^3}{2.6\,G} \times \frac{64}{\pi d^4} = .096 \times \frac{64\,P r^3}{G d^4} \quad or$$

$$\delta_1 = .096\ \delta_0 \quad or\ app.\ .1\ \delta_0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

where δ_0 = deflection per turn from Equation 1.

This checks the experimental work mentioned previously for the half coil turned up. For the full coil turned up part way the analysis is considerably more complicated and will not be discussed here.

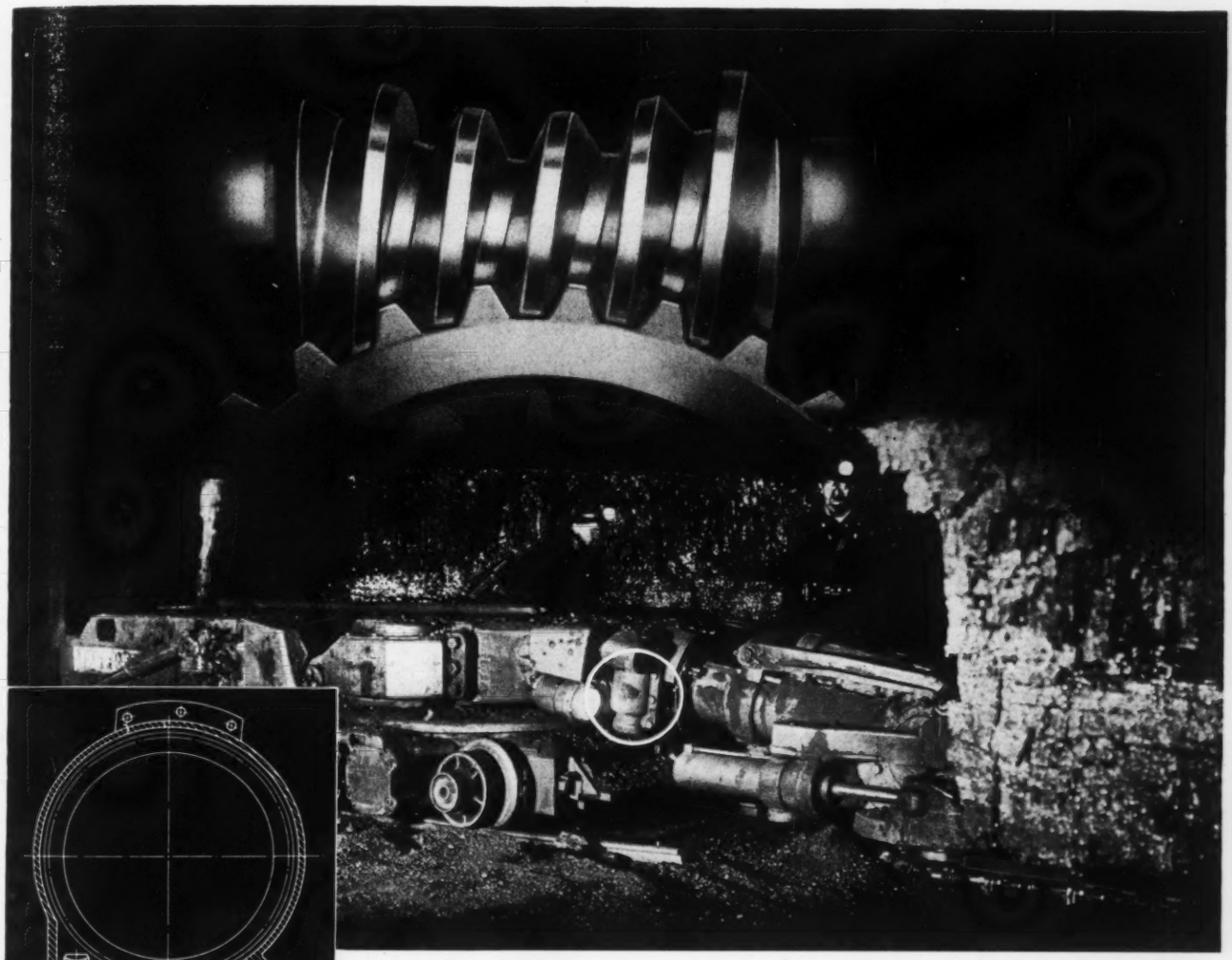
The effect of variations in spring dimensions has been considered previously[9]. Thus it may be shown that a 1 per cent change in the wire diameter means a 4 per cent change in the deflection at a given load. Likewise a 1 per cent change in the coil diameter means a 3 per cent change in the deflection. Since commercial wire stock may easily vary 2 per cent or more from the nominal value in many cases, while in coiling the springs variations in the coil diameter of 1 per cent or more may easily occur, it is clear that variations in the spring load-deflection rate due to such causes may be much larger than those due to variations, for example, in the modulus of rigidity, or to inaccuracy in the formula.

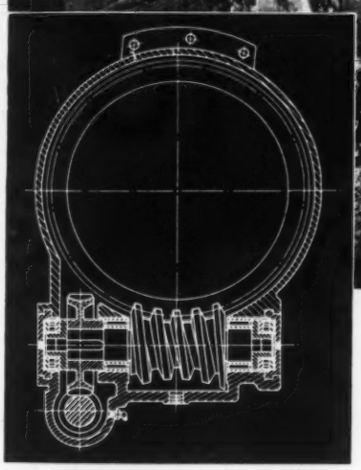
Both theory and experiment indicate that for practical springs the commonly used deflection formula is accurate to within about 1 per cent for most spring applications where spring indexes are greater than 4 and pitch angles under 10 degrees.

For very small indexes between 2½ and 4 and small pitch angles theoretical analysis indicates that the actual spring deflection may be as much as 2½ per cent less than the value obtained from the ordinary spring formula.

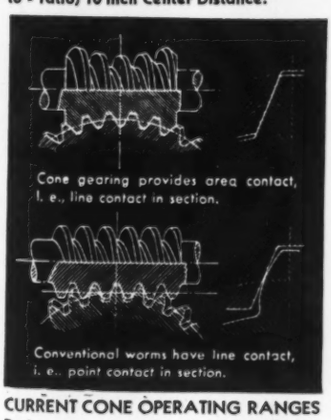
Factors which tend to make actual load deflection rates deviate from the calculated values in helical springs are: (1) Inaccuracy in the ordinary formula (but this is usually under 1 per cent except for very small indexes), (2) variations in the torsional modulus G, particularly those due to decarburization of the material, (3) change in modulus due to increase in temperature, (4) inaccuracy in estimating effect of end turns and (5) variations in coil diameter and wire diameter. Although (1) and (3) ordinarily are under 1 per cent except for elevated temperatures, the effects of (2), (4) and (5) may each amount to several per cent in certain cases. When these are added up, the actual load-deflection rate may easily deviate by 10 per cent or more from the calculated. This explains why spring specifications ordinarily allow for a load tolerance of ± 5 to 10 per cent at the design deflection. Closer tolerances than this require special precautions in spring manufacture and can usually be obtained only at increased expense.

(9) MACHINE DESIGN, March, 1938.





Cone Drive assembly as used in the Jeffrey 29U Universal Coal Cutter, shown above. Location of gears marked with Circle. 40 to 1 ratio; 10 inch Center Distance.


Cone gearing provides area contact, i. e., line contact in section.
Conventional worms have line contact, i. e., point contact in section.

CURRENT CONE OPERATING RANGES
Ratios . . . . . Low, 1 to 6; High, 180 to 1
Speed . . Low, 1/15 rpm.; High, 30,000 rpm.
Sizes (C. D.) Low, 5/8 in.; High, 27½ in.

Area-Contact Cone Drive Solves Clearance Problem

Some time ago The Jeffrey Manufacturing Company set out to design a really Universal Coal Cutter—a machine that would cut a 'room' to a width of 33½ ft., and cut it faster—that would bottom-cut and top-cut—that would cut and shear room-necks and crosscuts—that would hole break-throughs and slab ribs.

For the high capacity required, conventional gearing would not give the compactness necessary to provide proper head turn-over clearance. Smaller gears were necessary. Jeffrey engineers found that: "Cone worm gearing has less unit pressure and more efficiency than straight type worm gearing and permits the use of smaller gearing."

Thus, again, Cone gearing's AREA CONTACT—with more teeth in engagement—helped develop a better machine.

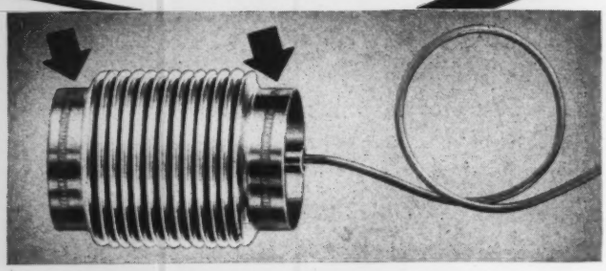
There are other important features exclusive with Cone type worm gearing. Both worm and wheel tend to regenerate each other in service, so that gears WEAR IN instead of out. Further, the engaging action of Cone worm and wheel teeth spreads oil on the contact surfaces instead of scraping it off, reducing wear, and increasing efficiency.

Our Engineering department will be glad to cooperate with you in working out drives that will cut your machine costs, decrease size, increase load capacity and improve efficiency and durability.

In the meantime, we suggest you send for Bulletin #CW-3b for further details.

CONE WORM GEAR DIVISION **MICHIGAN TOOL COMPANY**
7171 E. McNICHOLS ROAD, DETROIT

ELECTRIC RESISTANCE
Circumference SEAM WELDING
OF STAINLESS STEEL BELLOWS
to
STAINLESS STEEL
END FITTINGS



Completely sealed vacuum tight stainless steel bellows units, free from soldered, brazed, or torch-welded joints, are now available to meet conditions of elevated temperatures and actively corrosive media, where use of even silver solder is precluded. Metal end fittings and end seals are attached to metallic tubing by a recently developed method of electric resistance, circumference seam welding. Specialized welding equipment operates automatically, eliminating possibility of error due to human element present in other methods. Extremely thin gauges of metal can be handled. Metals of unlike thicknesses or unlike analyses can readily be joined. Send us details of *your* problems.

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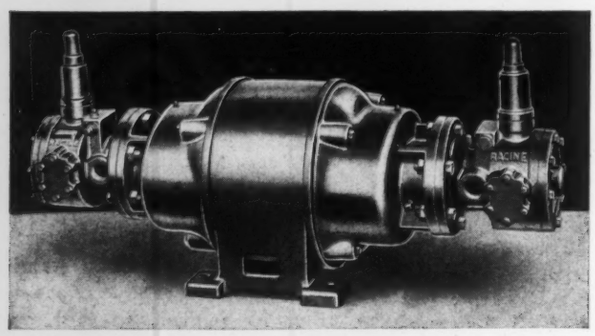
VARIABLE VOLUME HYDRAULIC PUMPS

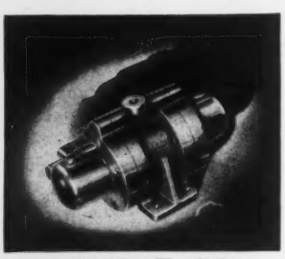


RACINE Pumps Flange Mounted. Available in foot type or single or double end flange type mountings.

Extremely quiet, smooth performance. A thoroughly proven, efficient pump for pressures up to a 1000 lbs. per sq. in. Capacities 2000-4000-6000 cu. in. per min.

The variable volume feature saves horse-power. Delivers amount of oil actually required. Volume controlled automatically or manually.

RACINE Pressure Booster—a variable or constant volume, hydraulically actuated, piston type pump. A self-contained economical unit converts low pressure systems to high pressure systems without additional motors or intervening mechanical drives. Write for further information.



RACINE TOOL & MACHINE CO.
1773 State St. Racine, Wis.

Meetings and Expositions

July 10-August 18—

Two summer sessions have been introduced by School of Design, 247 East Ontario street, Chicago, one to be held in the school building and the other at "Rummey Farm," Somonauk, Ill. Regular fall semester will begin Sept. 25.

Aug. 17-19—

American Transit Engineering association. Meeting to be held in Los Angeles. Further information may be obtained from G. C. Hecker, 292 Madison avenue, New York.

Aug. 28-31—

American Mining congress. Metal mining convention and exposition to be held at Minerals building, Salt Lake City. Julian D. Conover, 309 Munsey building, Washington, is secretary.

Aug. 28—Sept. 1—

National Association of Power Engineers. Annual meeting and exhibit to be held at Indianapolis, Claypool and also Lincoln, Ind. Fred W. Raven, 176 West Adams street, Chicago, is secretary.

Sept. 4-8—

American Society of Mechanical Engineers. Joint meeting with Institution of Mechanical Engineers of Great Britain, to be held in New York. Additional information may be obtained from C. E. Davies, 29 West Thirty-ninth street, New York.

Sept. 28-29—

Society of Automotive Engineers. National tractor meeting to be held at Hotel Schroeder, Milwaukee. John A. C. Warner, 29 West Thirty-ninth street, New York, is secretary.

Oct. 1-3—

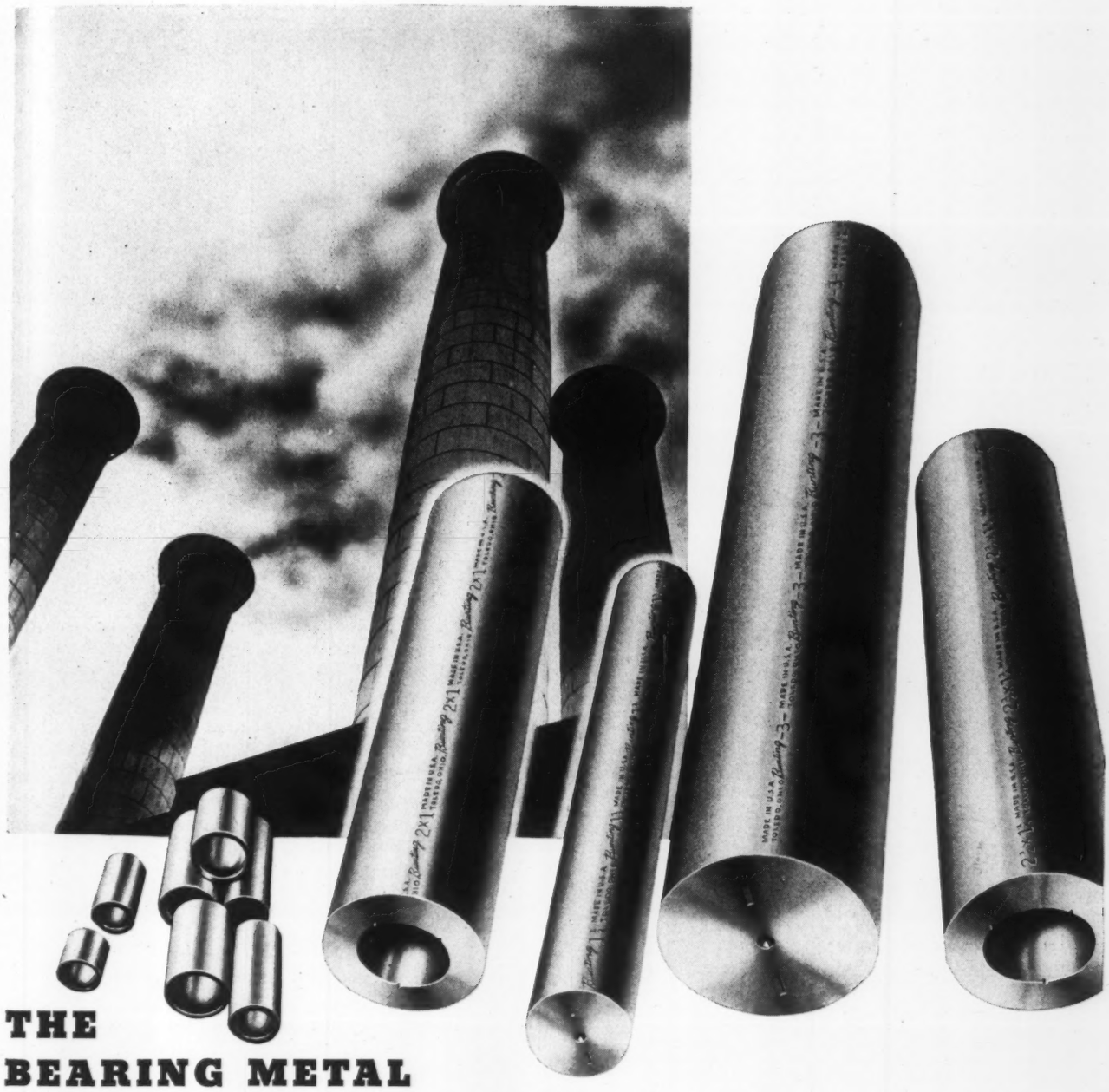
Society of the Plastics Industry. Fall meeting to be held at Westchester Country Club, Rye, N. Y. George K. Scribner, Boonton Molding Co., is chairman.

Oct. 4-13—

Machine Tool Show and Congress. Sponsored by the National Machine Tool Builders association. To be held in Public Auditorium, Cleveland. Additional information may be obtained by writing the association headquarters, at 10525 Carnegie avenue, Cleveland.

Oct. 5-7—

Society of Automotive Engineers. National aircraft production meeting to be held at Ambassador hotel, Los Angeles. Annual dinner of the society to be held at Hotel Pennsylvania, New York, Oct. 16. John A. C. Warner, 29 West Thirty-ninth street, New York. is secretary.



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● The shafts of American industry turn in Bunting Bronze Bearings.

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FOR PROFITS
MACHINE
TOOL SHOW
CLEVELAND
OCT. 4 to 13, 1939

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BRONZE BUSHINGS • BEARINGS
PRECISION BRONZE BARS
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for Supplying Coolant . . .
or for light transfer work

—Two New Centrifugal Motorpumps

Modern—
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Flexible in Installation . . . can be mounted either horizontally or vertically.

No. 240 has flange mounting integral with base... eliminating inlet piping.
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LUBRICATED FOR LIFE
The machine tool market asks for more pieces per hour. The machine tool asks for higher speed and more automatic control. The machine designer asks for ideas.
Let us help. Our engineers are ready to show you how Pulsolator can automatically lubricate your machines for life.
write for bulletin b-30
Rivett
Lathe & Grinder Inc.
Brighton, Boston, Mass
BLANCHARD PULSOLATOR

MANUFACTURERS' *publications*

ALLOYS (NICKEL)—Basic information on mechanical, corrosion-resistant and other properties of rolled nickel, monel and other high nickel alloys produced by The International Nickel Co., New York, is given in a new folder. Fabrication and heat treatment methods are discussed.

BEARINGS—Catalog No. 16 has been issued by The Gwilliam Co., 360 Furman street, Brooklyn, N. Y., describing its line of ball and roller bearings and containing illustrations of various types with lists of standard sizes.

BELTING—A new engineering data book published by The Manhattan Rubber Mfg. division, Raybestos-Manhattan Inc., 94 Townsend street, Passaic, N. J., is divided into two parts: Part one covers standard drives, eliminating the necessity of working out calculations, and part two covers sheave factors for designing new or special drives. Belt comparison tables are included.

CAST PARTS (ZINC)—Recommendations of die casters, large users of die castings, and tool manufacturers have been collected by The New Jersey Zinc Co., New York, in a new book, "Practice in Machining Zinc Alloy Die Castings." Every method reviewed is in actual commercial use. Illustrations are numerous.

CONTROLS (ELECTRICAL) — Allis-Chalmers Mfg. Co., Milwaukee, has just issued two new bulletins on switchgear. Bulletin B6012 describes its latest complete line of vertical-lift metalclad switchgear, is profusely illustrated, and includes full page dimension sheets and circuit diagrams helpful to the engineer. Bulletin B6011 has been enlarged and revised, covering the indoor cubicle type switchgear, and containing new installation views, dimension sheets and wiring diagrams.

CONTROLS (ELECTRICAL)—The D-51 magnetic motor starter made by General Electric Co., Schenectady, N. Y., is discussed in an illustrated folder in color, GEA-2964A, just issued. Parts making up the starter are carefully analyzed.

COUPLINGS (FLEXIBLE)—A leaflet just issued by The Falk Corp., Milwaukee, describes the action of the Falk Steelflex couplings in absorbing and damping shocks. Of added interest is an explanation, with cutaway photograph, of the construction of the coupling.

FASTENINGS—A four-page pamphlet has been published by the Pheoll Mfg. Co., Chicago, describing its Pheoll-Phillips recessed head screws and bolts which

Swifter-Smoother-More Accurate Drafting STARTS HERE FOR YOU

-with BRUNING-WALLACE TOUCH CONTROL DRAFTERS

that save from 25% to 40% Drafting Time

HERE'S a proved way to cut engineering costs — use Bruning-Wallace Touch Control Drafting Machines. Touch Control, an exclusive feature of these superior drafters, now brings new smoothness, ease and speed to drafting . . . without sacrificing the unfailing accuracy of the machine. Bruning drafters are accurate, and they stay accurate after years of operation — in any position — at any angle — on any part of the board. Bruning Touch Control Drafters multiply your drafting efficiency . . . enable you to get rush work out more quickly . . . introduce modern production methods into the drafting room and save 25% to 40% of drafting time. Bruning-Wallace Drafters pay for themselves in time savings and there's a type for every need. All are fully described and illustrated in a handsome new book. Fill out and mail the coupon for your free copy!

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It's not unusual for a $20.00-a-week stenographer to use a $100.00 typewriter and a $40.00 desk and chair. Your draftsmen, who often earn several times as much, should certainly have as good equipment! A Bruning-Wallace Drafter is modest in cost — yet if it increases a $2800.00-a-year draftsmen's efficiency ONLY 5% *(and most users claim 25% to 40% increase)* — the 5% increase in efficiency, speed or volume of work produced will pay for the drafter in 12 months — and provide enough extra savings to buy a new drawing table as well!

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SPEEDS — SIMPLIFIES — AND PROTECTS A NATION'S DRAFTING

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952-154

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Los Angeles: 818 Santee Street
Please send me a copy of your free booklet on Bruning Touch Control Drafters.

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Company _____

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Can be *accurately* ground *out of the solid AFTER HARDENING*

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WRITE FOR BULLETIN #25

TRICO FUSE MFG. CO., Milwaukee, Wis.

have been added to its complete line of fastenings. Illustrations are included to show advantages and applications of the recessed head screw.

FORGINGS—"Judge Amforge Holds a Radio Quiz," is the title of a new book presenting facts about upset forgings in an unusual, refreshing way, published by The American Forge division, American Brake Shoe & Foundry Co., 2621 South Hoyne avenue, Chicago.

GEARS (WORM)—Various applications of worm gears in transmitting power to slow and moderate speed machinery of all kinds is illustrated by appropriate photographs in leaflet E-1175, "Worm Gears in Industry," published by De Laval Steam Turbine Co., Trenton, N. J. Advantages of this type of drive are discussed.

MOTORS—Totally enclosed loom motors of ½ to 2-horsepower are described in booklet F-8484 of Westinghouse Electric & Mfg. Co., East Pittsburgh. These motors are for 220, 440 or 550-volt supply, 60 cycles, two and three phase.

OILERS—Bulletin No. 25 published by Trico Fuse Mfg. Co., Milwaukee, describes its new line of Opto-Matic oilers with unbreakable, reinforced reservoirs in which the oil supply is always visible.

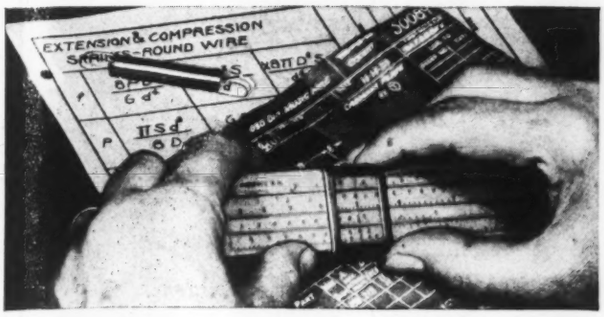
SPEED REDUCERS—Bulletin 22-11 published by Janette Mfg. Co., Chicago, describes various types of motorized and motorless speed reducers and gives brief characteristics and capacities of each.

STEEL (STAINLESS)—Rustless Iron & Steel Corp., Baltimore, has issued a new illustrated book discussing in detail the various types of Rustless stainless steels, giving their physical properties, structural characteristics, and resistances to corrosion and creep. Photomicrographs and charts are numerous.

STEEL—A detailed listing of the many new products and sizes recently added to Ryerson stocks is given in the Stock List & Steel Data book just published by Joseph T. Ryerson & Son Inc., Chicago. Weights, length, cutting data, and other pertinent information are given.

TUBING (FLEXIBLE METAL)—A 24-page catalog elaborately illustrated with 75 pictures and charts has been published by the American Metal Hose branch of the American Brass Co., Waterbury, Conn., covering seamless flexible metal tubing. The catalog contains discussions on the proper use of the product for conveying steam, liquids, gases; controlling vibration, connecting misaligned or moving parts. There are also complete engineering data and specifications.

VALVES—A 24-page photographic study of iron valve types, analyzing the factors of valve life and maintenance, is contained in Form 183, the "Inside Story of Jenkins 125-Pound Iron Valves," published by Jenkins Bros., 80 White street, New York. The booklet concludes with a handy reference chart giving types, sizes and figure numbers for ordering.



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Springs for precision and other important functions perform much better if carefully engineered before production. Our engineers often find that a slight change in diameter, shape, pitch or material will make an indifferent spring do a top-flight job!

If you have a spring problem, submit it to our Engineering Department for analysis. Perhaps, as a result of their long experience in this work, they can give you the answer you need. May we send you a catalog of Peck springs and screw machine parts? No charge if you write on your letter head.

PECK SPRINGS
AND SCREW MACHINE PARTS
The Peck Spring Co., 10 Wells St. Plainville, Conn.

POSITIONS

AVAILABLE OR WANTED

WANTED: Organization of three salesmen familiar with machine shop practice and special machinery design are interested in securing accounts to act as manufacturers' agent in St. Louis territory. Address Box 118, MACHINE DESIGN, Penton Building, Cleveland, Ohio.

WANTED: With several years engineering and manufacturing experience would like additional lines of industrial equipment to represent on commission basis in Central and Western New York. Have New York State professional engineer's license. Address Box 119, MACHINE DESIGN, Penton Building, Cleveland, Ohio.

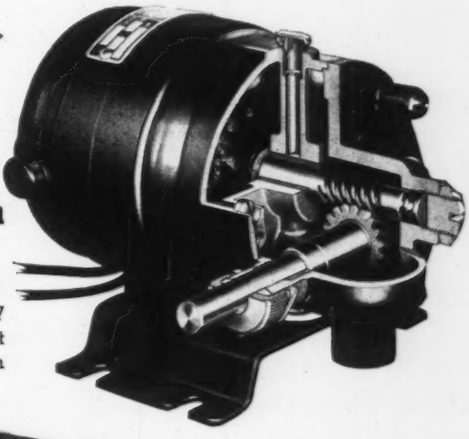
CLASSIFIED advertisements are set in eight point Stymie bold face type, approximately eight words to a line. Rates are as follows:

Positions Available—20c a word, with a minimum charge of $10.00, which permits the use of fifty words.

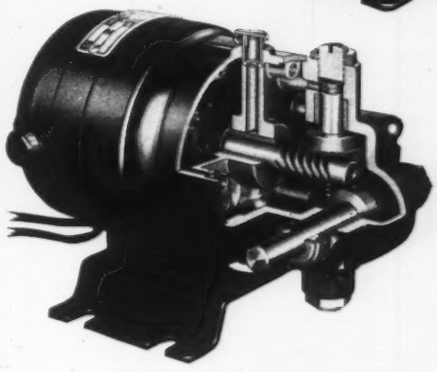
Positions Wanted—10c a word, with a minimum charge of $3.00, which permits the use of thirty words.

The box number will be counted as one line or eight words.

You can get BODINE SPEED REDUCER MOTORS in speeds down to 1.5 rpm!



Motor with Single Reduction
In speeds from 57 rpm up. Worm cut on shaft for high efficiency.



Motor with Double Reduction
In speeds from 1.5 rpm up. Low friction, silent gears and worms.

● Whatever the nature of your machine, there's a Bodine fractional horsepower speed reducer motor to fit it. Bodine offers over 1600 standard types—many more than any other manufacturer. Their precision-built parts and accurate, permanent alignment insure smooth, quiet operation and long life. These Bodine motors will enhance the sales value of your machine.

MAIL COUPON FOR BULLETIN!

BODINE

Bodine Electric Co., 2258 W. Ohio St., Chicago, Ill.
Please send me your new bulletin on speed reducer motors.

Name.....

Company.....

Address.....

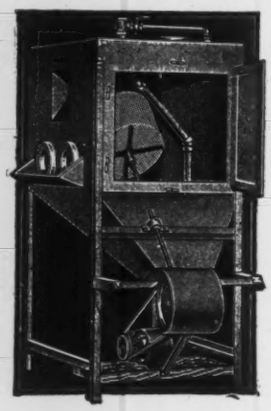
BODINE MOTORS
ENGINEERED FOR YOUR PRODUCT

A Real Labor Saver

LEIMAN BROS. PATENTED **Continuous Feed**

Sand Blast Outfit

For Manufacturers of Goods in Metal, Glass, Celluloid, Rubber, Wood and other materials



It furnishes a modern, cleanly way of cleaning moulding sand from patterns and castings. Letters and designs stencilled.

Will replace the scratch brush for mat finishing and similar effects on all classes of goods—it will replace the use of disagreeable acids for this work.

Finishes may be fine, medium or coarse on all materials as desired—but, most important, it will always be uniform—no streaky, uneven results.

Any article to be plated should be sand blasted first—it will result in a more permanent plate, a quicker plate, and a saving of time in plating and a saving of current.

The most inexperienced person can operate it without instructions—the work cannot be spoiled.

HARDENING SCALE REMOVED

makes machining quicker and better and Saves Cutting Tools—Gives better Color to Castings—Makers of Hardware, Tools, Gears, Machinery and Metal articles need the sand blast.

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LEIMAN BROS. Inc. 23 Walker St., New York
Makers of Good Machinery for 50 Years

MODERN MACHINE DESIGNERS ARE

CHANGING TO

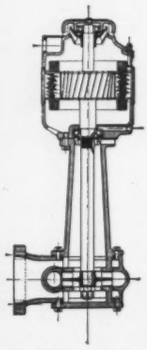
THE GUSHER COOLANT PUMP

The reason? Ruthman ball-bearing Gushers are modern in every way—the pumps of tomorrow—quiet, simple in construction and easy to apply to YOUR modern machines. Pipeless gushers add beauty to your machines.

Gushers have split-second control, will handle materials that contain grit and abrasives. Gushers are self-cleaning and are hydrostatically balanced. Gushers will end your coolant problems.

Model No. 11020A

BE MODERN USE "GUSHERS"



Model No. 11022 Patented and Patents Pending

Write for Engineering Specifications

THE RUTHMAN MACHINERY CO.
540 E. FRONT ST. CINCINNATI, OHIO

Business and Sales Briefs

ANNOUNCEMENT has just been made of the appointment of B. M. Horter as general sales manager for Cutler-Hammer Inc., Milwaukee. Mr. Horter, prior to his present appointment, was in charge of the resale sales division of the company.

♦

Well known throughout the intermountain territory, Urquhart Service Co., 1501 Wynkoop street, Denver, has been added to the list of sales representatives for Ajax Flexible Coupling Co., Westfield, N. Y.

♦

Air Reduction Sales Co., 60 East Forty-second sereet, New York, has appointed J. T. Gillespie Jr. as assistant to Thomas B. Hasler, president of Wilson Welder & Metals Co., an affiliate company.

♦

Merging of the General Electric Vapor Lamp Co., Hoboken, N. J., with the Incandescent lamp department of General Electric Co., has recently been announced by Charles E. Wilson, executive vice president of General Electric. With this change, the incandescent lamp department will be known as the lamp department of the company.

♦

New offices for the Diehl Mfg. Co., Elizabethport, N. J., have been opened in the Johnson building, Room 617, Charlotte, N. C. The office will be in charge of James H. Lewis.

♦

Frank S. O'Neil has been appointed general manager of Link Belt company's plants in Indianapolis, of which he had been assistant general manager for the past seven years. Mr. O'Neil's experience with the company dates back to 33 years ago.

♦

Vincent H. Godfrey has joined the general sales staff of Page Steel & Wire Division of American Chain & Cable Co. Inc., Monessen, Pa.

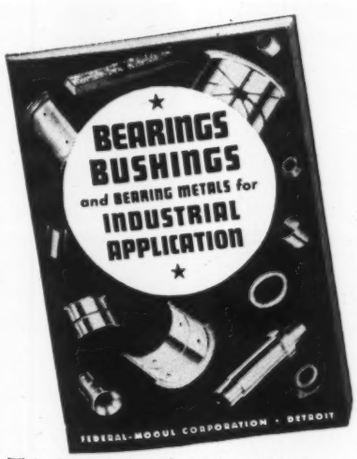
♦

On the retirement of J. B. Cooper, manager of the district office at Phoenix, Ariz., for Allis-Chalmers Mfg. Co., this and the El Paso, Texas offices will be combined into one district, to be known as the El Paso district. Formerly manager of the El Paso office, O. F. Metz has been made district manager of the combined new territory, with offices at El Paso.

♦

Thomas V. Brooke, for several years associated with the Lincoln Electric Co. as research engineer, has been appointed sales engineer of the Lincoln Electric Rail-

MILLIONS OF BEARINGS AND BUSHINGS EACH YEAR... OUR *experience* IS AT YOUR SERVICE



This interesting booklet "Bearings, Bushings and Bearing Metals for Industrial Application" will be sent free of cost when requested on your business letterhead.

Small runs are an important part of Federal-Mogul's annual volume of production, which includes bearings, bushings, bearing parts, bronze bars and babbitt metals. Forty years' specialization and wide variety in bearing products manufactured, assures wide, practical experience in design, development and ability to produce. Federal-Mogul bearings are supplied for all types of installations, ranging from tiny electric motors to steam shovels, and including washing machines, vacuum cleaners, automobiles, aircraft, compressors, etc. This experience has enabled us to effect important improvements in bearings for many users. The application of insert precision-type bearings in place of poured bearings, thus reducing cost, increasing bearing life and solving an awkward replacement problem, is a typical example. To any manufacturer or engineer whose job is the development of bearings for new equipment, or modernizing old, this bearing consultation service is offered, without cost or obligation. If you wish, send us blueprints. We are glad to consult with you.

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Pacific Division: 210 Van Ness Ave. S., San Francisco, Calif.

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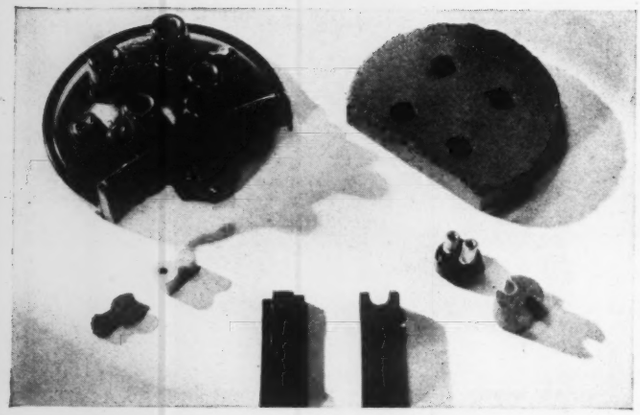
FEDERAL Mogul



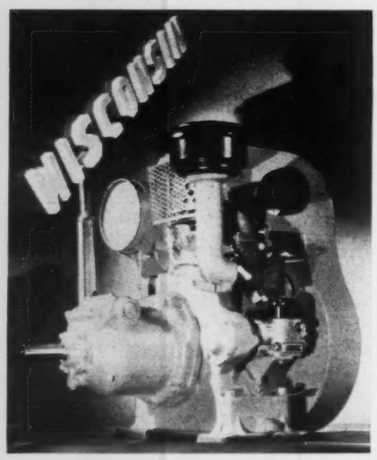
Preformed
FOR PERFECTION

Perhaps you never have seen plastic parts actually molded. That's why we show you above the preforms that precede the actual molding operations together with the finished parts.

The right shape and amount of molding compound insures economical manufacturing. Too little causes "shorts" or unfilled pieces that are rejected. Too much causes excessive fins that raise finishing costs.

That's why Auburn's more than 60 years of experience applied to such details gives you the most for your money. A trial order will show you just what that means to you.

MOLDED PLASTICS DIVISION OF
AUBURN BUTTON WORKS, Inc.
AUBURN, N. Y.—New York, Chicago, Detroit, Cleveland, Rochester, Boston



A reproduction of Model AG with clutch and power take-off.

•

10 sizes—1 to 30 H. P.

....NO NEED TO "WET-NURSE" WISCONSIN AIR-COOLED ENGINES

No water to give trouble in freezing or boiling temperatures. No grease cups or oil fittings which are always neglected. Wisconsin air-cooled engines take care of themselves.

HEAVY DUTY AIR COOLED ENGINES by WISCONSIN MOTOR CORPORATION

WISCONSIN
MOTOR CORP., MILWAUKEE, WIS.

way Sales Co. in its Chicago office. The headquarters will be at 310 South Michigan avenue, Chicago.

♦

Arrangements for purchasing equipment and facilities of General Laminated Products Inc., New York, have been announced by General Electric Co. Distribution and fabrication of Textolite laminated materials will now be assumed by the company's plastics plant, Meriden, Conn. General Laminated Products Inc. of Illinois, will continue as fabricator and distributor of the material in the Middle West.

♦

Formerly associated with Plaskon Co. Inc., Charles E. Slaughter has become sales manager of Universal Plastics Corp., New Brunswick, N. J.

♦

Transfer of all production activities to its new plant at Cambridge, O., has been made by Reynolds Molded Plastics, Division of Reynolds Spring Co. All sales, engineering and accounting will be handled from the company's general offices in Jackson, Mich.

♦

Election of officers for American Carbide Alloys Corp., newly-acquired subsidiary of Firth-Sterling Steel Co., has been announced. They are: L. Gerald Firth, president of Firth-Sterling, is president of the new company; G. A. Jacobs of the company's Detroit office, first vice president; W. H. Lolley, second vice president, and George Kanepper of Detroit, chief engineer. The main office and works of the new company will be located in Detroit, with all equipment and stock located at American Carbide's plant at Lewiston, Me., being transferred.

♦

Burdon B. P. Hyde has been elected a vice president of the Scovill Mfg. Co., Waterbury, Conn.

♦

Jackson-Alden Associates, Philadelphia, has been made eastern representative for Ajax Steel & Forge Co., Detroit.

♦

Distinction has been given to Raymond Loewy, New York, industrial designer, by being named a "Royal Designer to Industry" by the Royal Society of Arts of Great Britain. He is the first non-British subject to receive this recognition.

♦

Succeeding W. W. Noble, William G. Hassel has been appointed Detroit district manager of Pittsburgh Crucible Steel Co., in charge of sales and metallurgical activity. Mr. Noble has been transferred to the Cleveland office as district manager.

♦

H. Leigh Whitelaw, formerly vice president of American Gas Products Corp., has become associated with Jones & Laughlin Steel Corp., Pittsburgh.

♦

Borg-Warner Corp., Chicago, has purchased the Pump Engineering Service Corp., Cleveland, airplane parts manufacturer.

NEW MACHINES—

And the Companies Behind Them

(For illustrations of other outstanding machinery see Pages 50-51)

Air Conditioning

Electrically-driven dust collector unit, Leiman Bros., New York.

Domestic

Oil Burner, Anchor Post Fence Co., Baltimore, Md.

Industrial

Air-motored mixer, Eclipse Air Brush Co. Inc., Newark, N. J.

Maintenance (Streets)

Motor pickup sweeper for gutter lane, Frank G. Hough Co., Chicago.
Portable air compressor, Sullivan Machinery Co., Michigan City, Ind.

Metalworking

Automatic milling machine, Cincinnati Milling Machine Co., Cincinnati.
Press brake, Dreis & Krump Mfg. Co., Chicago.
Drilling machine, Bradford Machine Tool Co., Cincinnati.
Crankshaft tapping machine, A. P. Schraner Co., Cleveland.
Hand grinders, Hisey-Wolf Machine Co., Cincinnati.
Coupling tapper, Acme Machine Co., Muncie, Ind.
Deluxe grinder, Baldor-Electric Co., St. Louis.
Adjustable gap demagnetizer, Blanchard Machine Co., Cambridge, Mass.
Heavy-duty lathes, Lehman Machine Co., St. Louis.
Hydraulic press, Hannifin Mfg. Co., Chicago.
Automatic polishing and buffing machine, The Packer Machine Co., Meriden, Conn.
Internal-external grinder, The Standard Electrical Tool Co., Cincinnati.

Mining

Pump, Peerless Pump Div., Food Machinery Co., Hoopeston, Ill.
Tractor shovel, Maine Steels Inc., South Portland, Me.

Photography

Camera lamp, C. F. Pease Co., Chicago.
Film and paper cutter, H. H. Robertson Co., Chicago.

Plastic

Vacuum mixer, Read Machinery Co. Inc., York, Pa.

Restaurant

Dishwashing machine, Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.

Roads

Self-propelled grader, Caterpillar Tractor Co., Peoria, Ill.
Self-powered scraper, R. G. Le Tourneau Inc., Stockton, Calif.

Rubber

Precision electric hydraulic vulcanizer, H. H. Heinrich Inc., New York.

Stamping

Nameplate stamping machine, H. O. Bates, Elizabeth, N. J.

Textile

Automatic bobbin winder, Universal Winding Co., Providence, R. I.
Rayon and duck loom, Draper Corp., Hopedale, Mass.
Automatic double seamer, E. W. Bliss Co., Brooklyn, N. Y.
High speed beaming machine, Robert Reiner Inc., Weehawken, N. J.

Water Pump

Shallow and deep well pumps, Crane Co., Chicago.

Welding

Direct current welder, Wilson Welder & Metals Co., Inc., New York.
Alternating current welder, Westinghouse Electric & Mfg. Co., East Pittsburgh.
Multi-arc welder, Harnischfeger Corp., Milwaukee.
Spot welding machine, Harvey Machine Co., Los Angeles.
Pincher type welding gun, Progressive Welder Co., Detroit.

Wire

Wire covering machines, Fidelity Machine Co., Philadelphia.

Woodworking

Rod or dowel mahcine, J. A. Fay & Egan Co., Cincinnati.
Double surfacer, Baxter D. Whitney & Son Inc., Winchendon, Mass.
Straight-line ripper, Mattison Machine Works, Rockford, Ill.
Rubber roll glue spreader, Black Bros. Co. Inc., Mendota, Ill.
Gang stile borer, Wilkin-Challoner Co., Oshkosh, Wis.
Carving machine, Woodworkers' Tool Works, Chicago.

2 BIG ADVANTAGES

--get both by specifying KNURLED

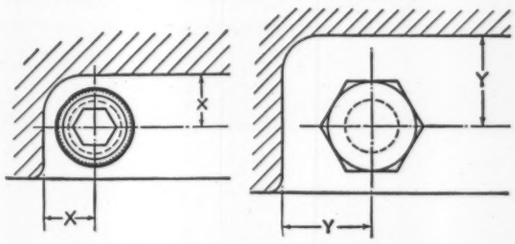
Fig. 1434 Pats. Pend.

UNBRAKO

SOCKET HEAD CAP SCREWS

1-MORE COMPACT DESIGNS

A decided saving is possible in clearance, material, weight and cost. Notice how close to the corner the "Unbrako" is placed, in the plan view below. Compare with the placement of ordinary screws which require setting back to allow for hex head and wrench. *See—and save—the difference!*



See how the Knurled "Unbrako" snuggles right into the corner.

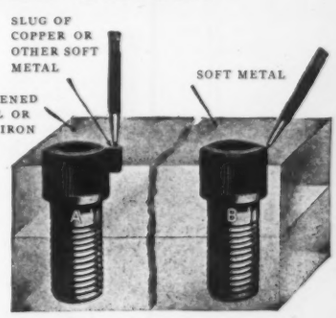
Notice the great open spaces necessary for the hex head and wrench.

2-LOCKS EASILY

The Knurled "Unbrako" can be locked firmly in place by two simple, effective methods.

When the screw is inserted in hardened metal, the soft metal slug (as shown by "A" in the illustration) locks it securely by being spread into the knurls of the screw with the aid of a locking tool. And—in soft metal, illustration "B" shows the easy way of locking.

No other screw has all the advantages of this modern, knurled "Unbrako"!



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This Proves It . . .

When it comes to the performance of machines, Veeder-Root Counting Devices put everything in black and white. Production is determined—pieces, lengths and volumes produced are recorded. Even the operations of machines—the starts and stops—are accurately counted. All by Veeder-Root Counting Devices. And from these devices, operators know exactly what their machines are doing—and the manufacturers of those machines know they are making good on the job.

Some go further. Veeder-Root devices are used to compute sales—like the "Head for Figures" in gasoline pumps. Others are used to register deposits—as in vending machines. Still more, to control machines—to prevent short or over-runs. And Veeder-Root engineers are constantly working on new and profitable applications that might be of interest to you.

Look further into Veeder-Root Counting Devices. Send for our booklet, now.

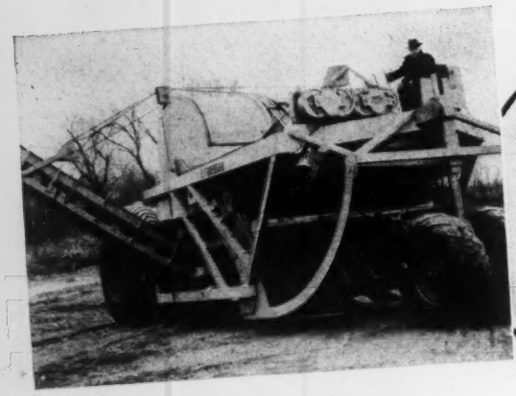
VEEDER-ROOT Inc.

HARTFORD, CONNECTICUT, U. S. A.

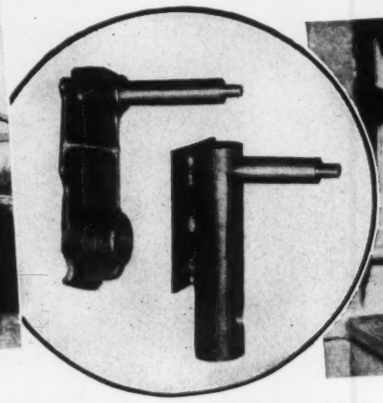
OFFICES IN Boston, Chicago, Cincinnati, Cleveland, Detroit, Greenville, S. C., Los Angeles, New York, Philadelphia, Pittsburgh, St. Louis, San Francisco, Montreal, Canada, Buenos Aires, Mexico City, London, Paris, Tokio, Shanghai, Melbourne

GET AHEAD WITH WELDING

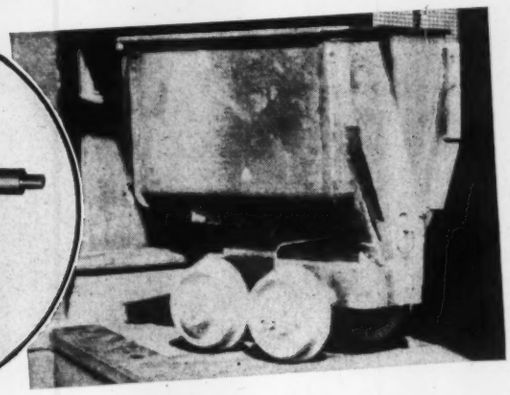
Be the man who gets credit for economies and improvements like these



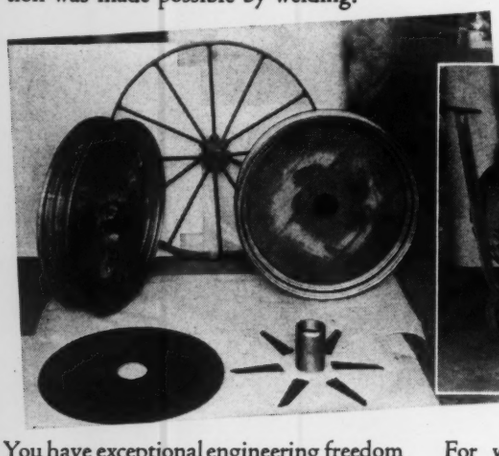
You can gain recognition for advancement by using welded steel for developing machines that would be impractical or uneconomical to build by other methods. Example: This all-welded sugar cane harvester, designed and built by R. G. Le Tourneau, Inc., Peoria, Ill., for lowering harvesting costs. Its construction was made possible by welding.



Change over one part at a time to welded steel construction. Example: A bearing for a cement buggy. Former construction, shown on the left, weighed 12 lbs. Welded steel bearing, shown on the right, eliminates five drilling operations and one slotting operation. It weighs 8¼ lbs. and is unbreakable.



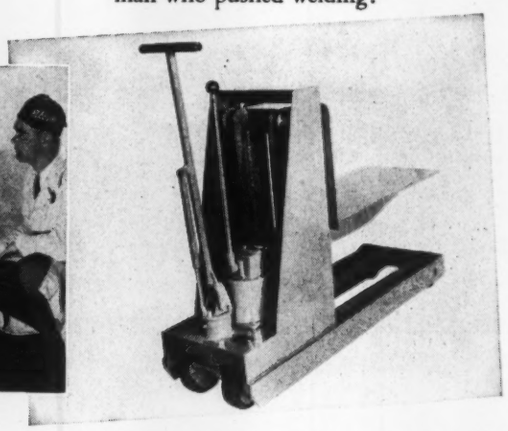
Welding saves weight, reducing operating cost of materials handling equipment such as this copper ore car. Formerly riveted, it weighed 1300 lbs. Built with 5/32" high-tensile steel plate—welded with *"Shield-Arc 85"* Electrode—the car weighs only 700 lbs.—600 lbs. less to pull around! That's headway for the man who pushed welding!



You have exceptional engineering freedom in designing for welding because you have your choice of scores of different shapes and types of steel. Example: A wheel for a cement buggy, built from pressed steel rim, plate disc and stiffeners and pipe hub. Former design is shown in the background. Photos of wheel and bearing (above) courtesy Red Star Products Co., Cleveland, Ohio.

For widest welding range and lowest welding costs, see that your shop is equipped with Lincoln Welders. Both *"Shield-Arc"* (left) and *"Shield-Arc Junior"* (right) have exclusive Self-Indicating "Job Selector" and Current Control for maximum speed and quality on every job.

For further details, consult the nearest office or mail the coupon



Increased sales appeal can be secured by streamlining machines with welded design. This neat-appearing lift-truck is of practically 100% welded steel construction using bars, plate and angle. With welded design, a wide range of types and capacities can be produced at minimum cost, without delay. Photo courtesy Lyon Iron Works, Greene, N. Y.

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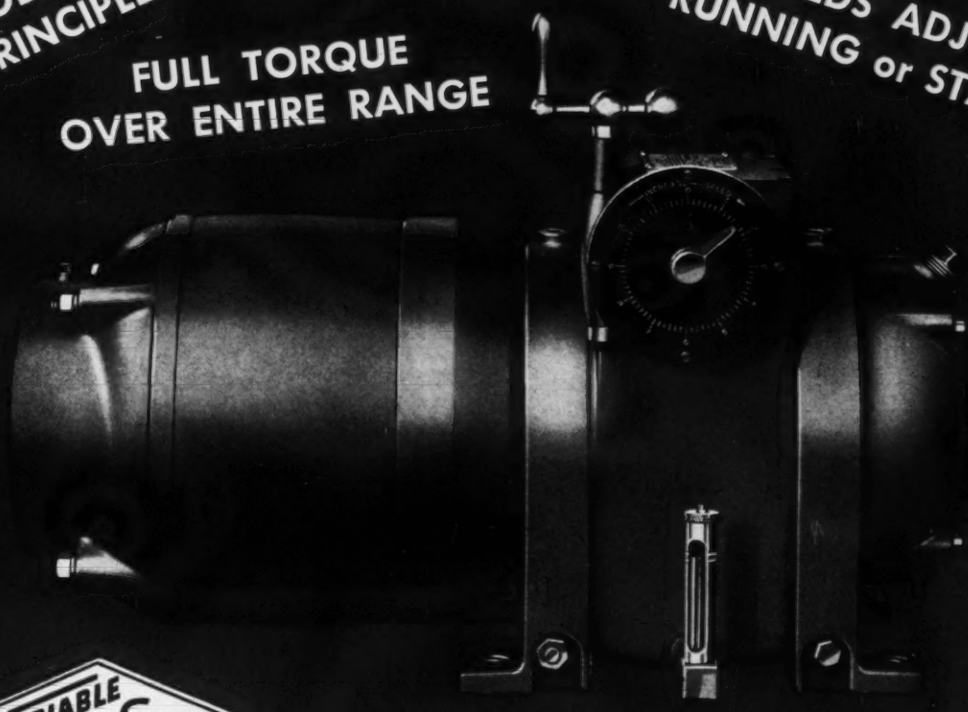

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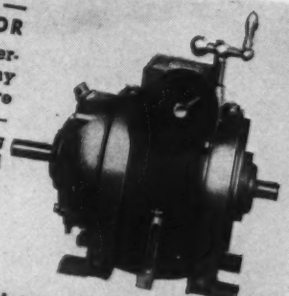

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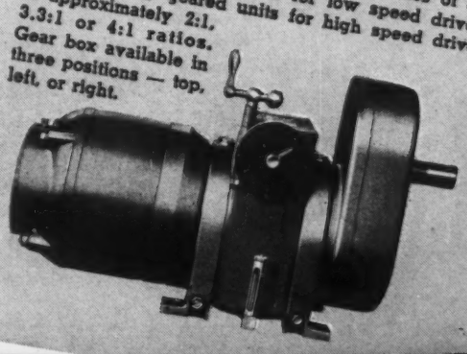

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